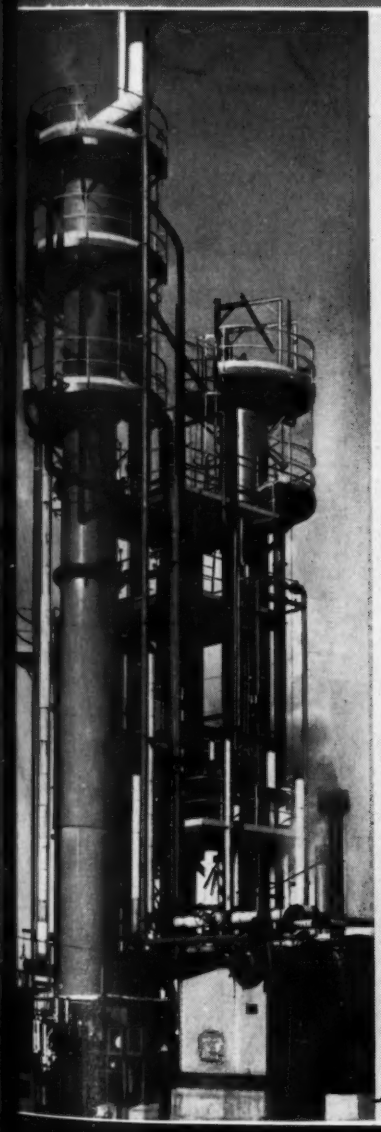
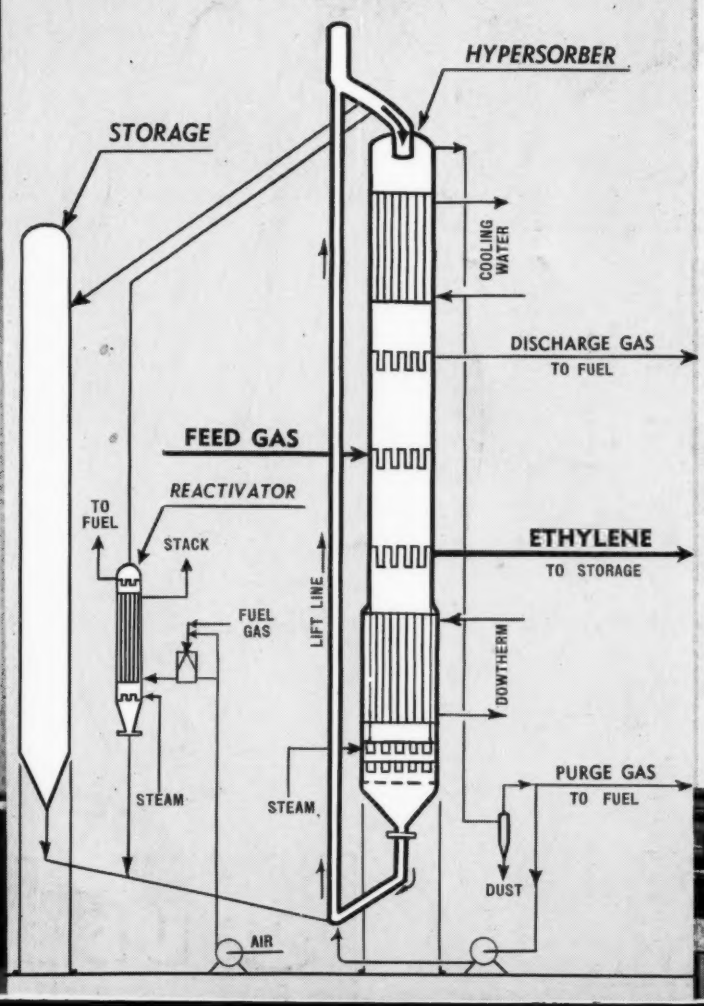
PETROLEUM PROCESSING

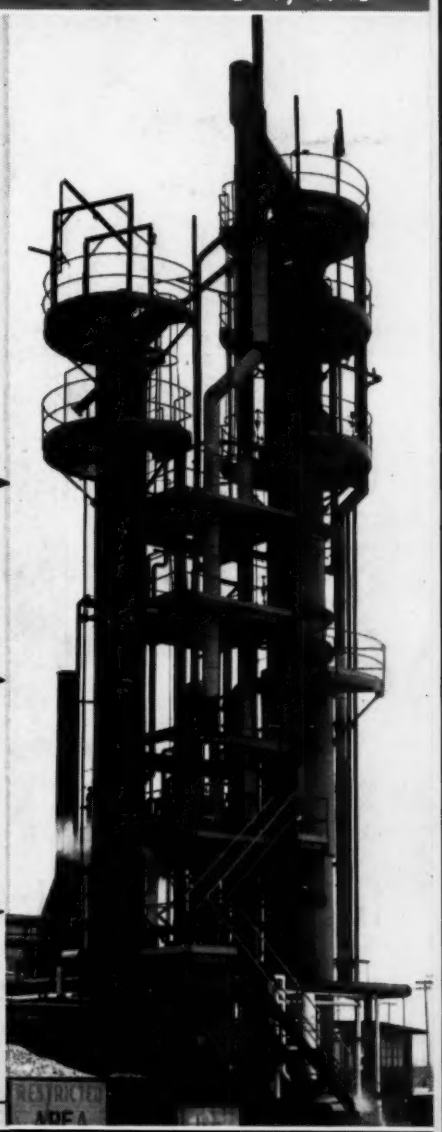
VOLUME 3, NUMBER 7 JULY, 1948



First Commercial Hypersorber

(See page 635)





FORMERLY MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS

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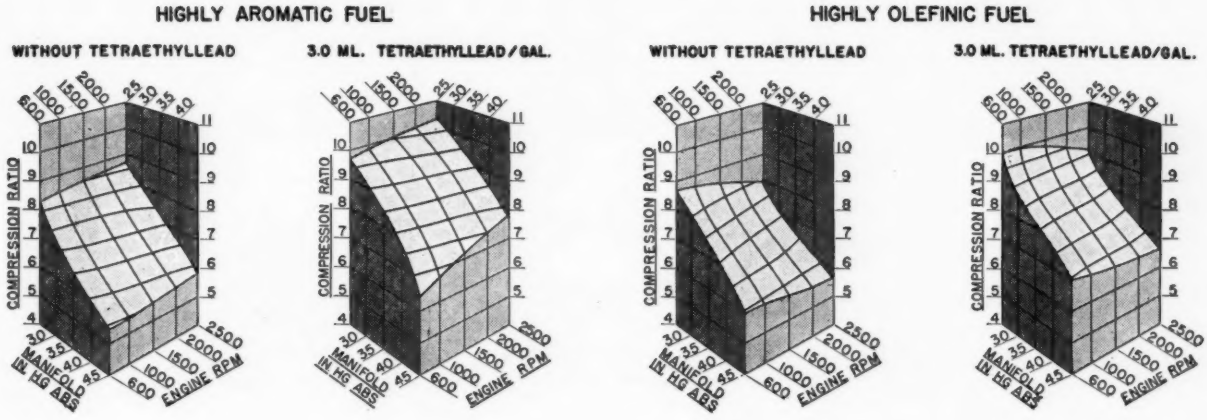
THE ETHYL CORPORATION SERVES THE PROGRESSIVE PETROLEUM INDUSTRY *Through Research*



Knock-limited compression ratio and intake manifold pressure over a range of engine speed, as measured on the special single-cylinder research engine.

Fuel antiknock profiles may be used to indicate the performance of gasolines of equal ASTM octane number but different chemical composition under a wide range of engine conditions.

New special single-cylinder engine provides complete profile of fuel characteristics

PROGRESS in design of automotive engines, coupled with progress in gasoline refining, necessitates knowledge of fuel knocking characteristics which includes much more than Research and Motor Method octane numbers. Those responsible for such progress must necessarily understand the potentialities of different fuel types in respect to compression, volumetric efficiency, temperature and speed of engines in which fuels may be used.

Road antiknock determinations do not provide the range of information required or a fixed base line to which all findings can be related over an indefinite period. For example:

1. Neither standard nor modified present cars reflect accurately the fuel requirements of future automobiles.

2. Yearly model changes introduce changes in fuel rating characteristics.

These problems have been met in the Ethyl Laboratories by the design and construction of a special single-cylinder knock testing engine capable of operation at variable compression ratio over the speed range of automobiles, with natural aspiration or supercharging.

With this engine, data may be obtained which permit the construction of charts similar to those above, showing for a given severity of operation the possible knock-limited combinations of compression ratio, manifold pressure and engine speed for a given fuel.

A tool for the development of future fuels

The special single-cylinder research engine in the Ethyl Laboratories is particularly well adapted to programs involving fuel development. Under carefully controlled conditions, antiknock determinations can be made over a broader range of conditions than is ever likely to be encountered in service. Extreme flexibility of adjustment of the engine and all associated equipment makes it possible to duplicate the complete range of service conditions and of fuel ratings without resort to abnormal adjustments. This versatile knock testing equipment is used in Ethyl's program of service to the oil industry through:

1. Implementing complete explorations of the antiknock characteristics of experimental fuels.

2. Providing a fixed base line against which comparisons can be made in the development of engines and gasolines.

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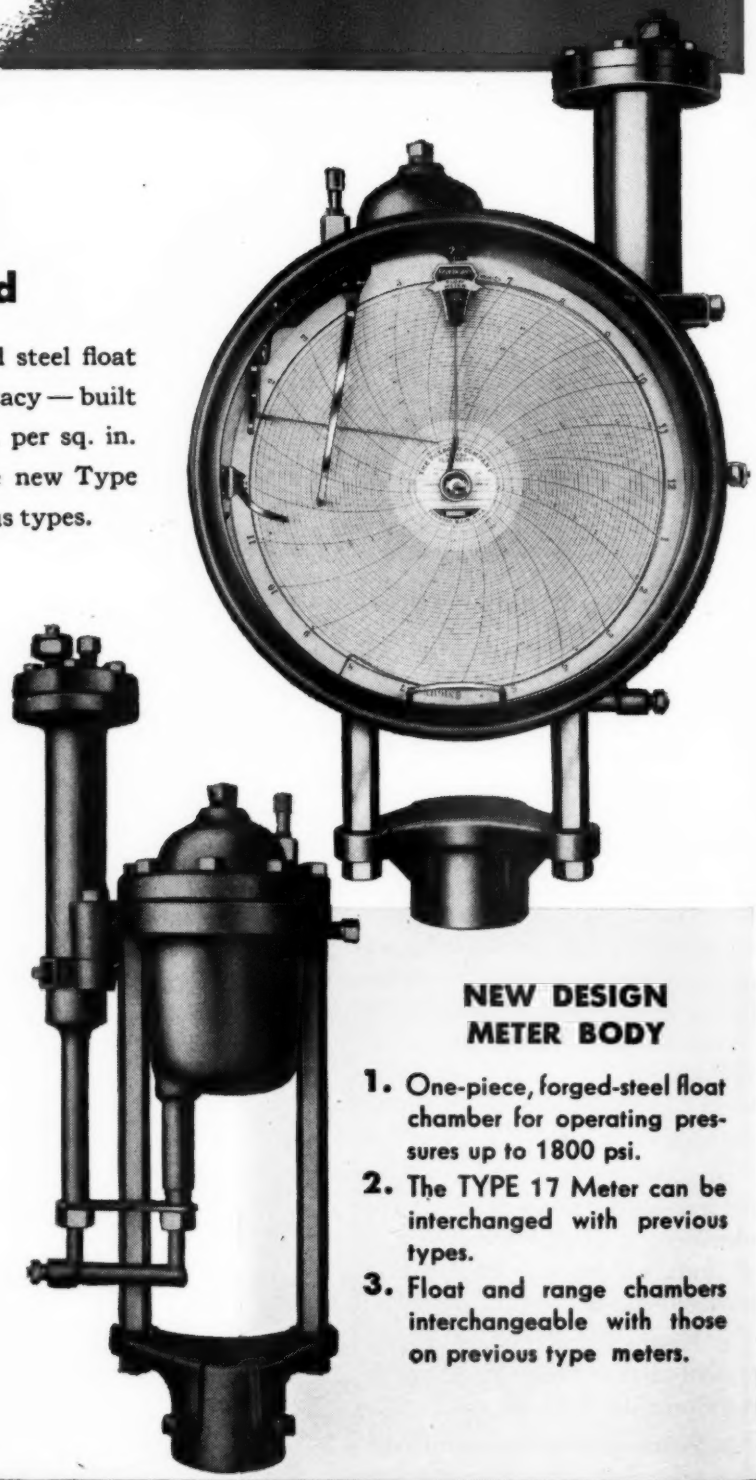
. . . offering highest sustained accuracy of any meter in its field

Here's a new flow meter with a one-piece forged steel float chamber — precision-bored for unequalled accuracy — built to withstand operating pressures up to 1800 lbs. per sq. in. Giving extra service at no increase in cost, the new Type 17 meter can readily be interchanged with previous types.



IN ADDITION . . .

this new Type 17 has all the unique features that have made Foxboro Flow Meters the unquestioned leaders in the oil and gas fields:

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Check all these advantages and see why the new Type 17 Meter is rated in a class by itself.

Other Foxboro Meters are available for operating pressures up to 5000 lbs. Write for Bulletin 351 and specific information on the new TYPE 17. **The Foxboro Company, 246 Neponset Ave., Foxboro, Mass., U. S. A.**

NEW DESIGN METER BODY

1. One-piece, forged-steel float chamber for operating pressures up to 1800 psi.
2. The TYPE 17 Meter can be interchanged with previous types.
3. Float and range chambers interchangeable with those on previous type meters.

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ABC

VOLUME 3
NUMBER 7
JULY, 1948
PUBLISHED
MONTHLY

PETROLEUM PROCESSING

OTHER PLATT PUBLICATIONS:
NATIONAL PETROLEUM NEWS
OILGRAM NEWS
OILGRAM PRICES
PLATTS'S OIL PRICE HANDBOOK

Covering the Management, Design, Operation, Equipment, Products of Plants Processing Crude Oil and Natural Gas into Fuels, Lubricants, Chemicals

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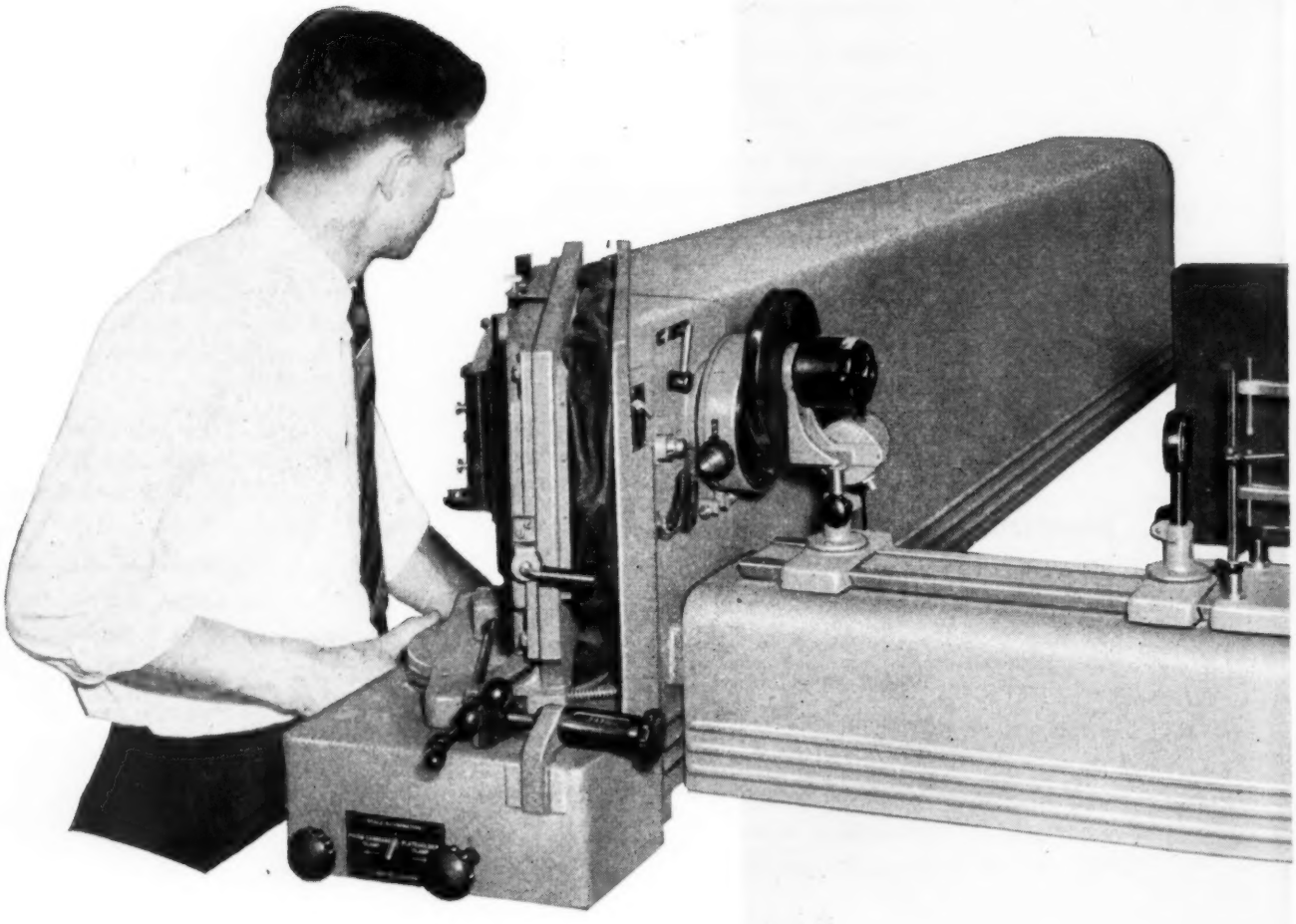
Research can be

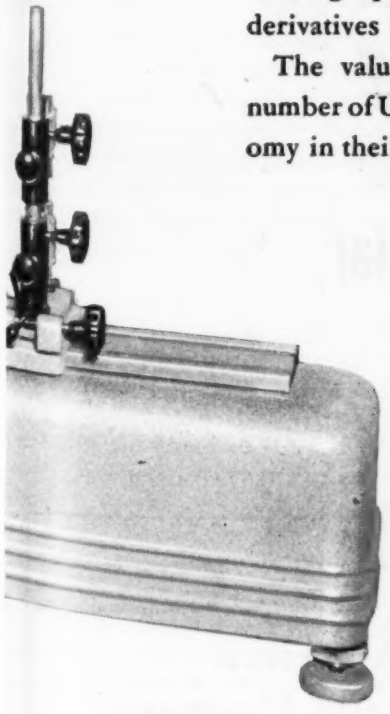


a colorful business

While a refiner's gasoline may appear water white to the human eye, the colors which characterize it when seen through a spectrograph in the Universal laboratories, are the keys to its actual composition. Using infrared and ultraviolet rays, hydrocarbon research is truly a colorful business.

The purpose of this research is not merely to satisfy scientific curiosity, but rather to determine facts which may be applied to present or future refining operations . . . to the improvement of motor fuels and the other derivatives of crude oil.

The value of Universal's hydrocarbon research? It's proved by the number of UOP licensee refiners who have found new efficiency and new economy in their operations . . . who have tailored their product for their market.



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What's Happening!

JULY 1
1948

Summary of Current News Developments Concerning Oil Men

SYNTHETIC FUELS

Gulf Oil Corp. and Koppers Co. have entered into a cooperative research and development program on processes for the conversion of coal to gas and liquid fuels. Work under the joint program, announced June 3, is already started, and both companies are understood to have been working for some time independently on matters associated with the production of synthetic liquid fuels.

This is the second such agreement between a major oil firm and a company associated with the coal industry. Last year Standard Oil Development Co. and Pittsburgh-Consolidation Coal Co. entered upon a similar joint research project.

First bulk shipment of crude shale oil from the Bureau of Mines' new oil shale demonstration plant near Rifle, Colo., was made last month to Universal Oil Products Co., Chicago. A railroad tank car of 6369 gal. of the crude oil was delivered to the company's laboratories and is now undergoing preliminary tests. It will be fractionated into various grades of crude oil, after which Union Oil Co. of California will conduct cracking and other refining studies in its California laboratories.

Stanolind's hydrocarbon synthesis plant near Garden City, Kans., will be known as the "Stanosyn Plant." Work on clearing the site was to have been started July 1 by Stone & Webster Engineering Corp., and construction schedules for the three major plant units are expected to be set shortly. These include the oxygen plant, synthesis unit, and chemical recovery plant.

• • •

EXPANSION

Skelly Oil Co. has expanded the enlargement and modernization program for its El Dorado, Kans., refinery. It was originally planned to install a 30,000-bbl. crude distillation unit and catalytic cracking plant, which would replace existing 25,000-bbl. crude facilities and augment present thermal cracker. Latest plans have upped the size to 35,000 b/d crude charge capacity, with commensurate capacity in the new catalytic cracking unit. M. W. Kellogg Co. is the contractor and expects to complete program by January, 1950.

Standard Oil Co. of California expects its new $3,500,000 wax plant at Richmond, Calif., will be completed in September. The new plant will produce 45 million pounds of petroleum-derived wax annually for use in the manufacture of such items as milk cartons, wax paper, pharmaceuticals, etc.

Sunray Oil Corp.'s 20,000 b/d Fluid catalytic cracking unit at its Duncan, Okla., refinery went on stream early last month. The plant, built by government during war at a cost of nearly $15 million, was purchased last August by Sunray from War Assets Administration for $5,100,000 and has been completely remodeled. Equipment now in operation includes topping and catalytic cracking facilities, a 10,000 b/d vacuum unit, 5000 b/d viscosity breaking unit, electrolytic desalting, gas concentration and polymerization units for butane and propane production.

• • •

TRANSITION

Continental Oil Co. has purchased the toluene plant erected at Ponca City, Okla., during the war by the Defense Plant Corp., and used in the manufacture of nitration grade toluene and aviation gasoline. Purchase price was said to be approximately $175,000. The plant has been used periodically by Continental since the latter part of 1946 on a lease basis for the manufacture of gasoline and other products.

• • •

SUPPLY and DEMAND

Another record for refinery operations was chalked up last month. During the week ending June 5, crude runs to stills soared to 5,736,000 b/d, or 98.3% of rated capacity. That percentage, however, is probably higher than actual, since API's rated capacity figure has not been adjusted for some months to take into account new and increased crude facilities that have gone on stream during that period.

Crude production kept pace, setting a new record each week for six consecutive weeks during May and June. Peak was reached during week ending June 19, with 5,479,600 b/d. Daily average crude production in the U. S. during 1947 was just slightly above 5,492,350 b/d.

Consumption of LP-Gas in 1948 will run between 25% and 30% above 1947, G. L. Brennan, general manager of the LPG Division of Warren Petroleum,

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

estimated in a speech before the Liquefied Petroleum Gas Assn. convention in Sacramento, Calif., last month. He also said that it was his guess that 1949 would be considerably ahead of 1948, but probably by a slightly smaller percentage.

Butane and propane production, according to Brennan, will increase "by a large amount" due to the construction of a large number of natural gasoline and recycling plants over the next 18 months. In addition, he said, greater production at old plants and at refineries, particularly of propane at the latter, will contribute to the LPG supply.

• • •

PETROCHEMICALS

Synthetic varnish from petroleum has been developed in the laboratories of Shell Development Co. The varnish is said to be the first one that is completely synthetic, using no natural oils, and is based on glycerol alpha allyl ether made from propylene. Shell reports that tests of varnishes made with the material give a surface of "unusual hardness, good flexibility and extreme toughness."

• • •

PEOPLE

C. E. Allen succeeds Fred Powell as president and director of the California Refining Co., Standard Oil Co. of California affiliate in the east. Powell is leaving to become general manager of Socal's El Segundo, Calif., refinery. Allen has been connected with the parent company for 17 years.

Charles D. Lowry, Jr., organic chemist for more than 20 years with Universal Oil Products Co., Chicago, is now executive director of the newly organized petroleum panel of military establishment's Research and Development Board. Panel's main objective is to coordinate military research on products, containers, and handling equipment.

William J. Murray, Jr., Texas railroad commissioner, has taken himself out of the picture as possible successor to Director Max Ball of Interior Department's Oil & Gas Division. Ball plans to resign his post shortly and recommended Murray, but the latter declined, saying he preferred to stay in state field.

• • •

WASHINGTON

Unfinished legislation left by Congress when it adjourned last month may still have a chance for passage this year. Speculation in Washington is that President Truman may recall Congress after the national conventions of both parties are out of the way. If Congress does not meet again before Jan. 1, 1949, all unfinished legislation automatically dies and a new start will be necessary next year.

Among business of interest to petroleum processing industry and not completed at time of adjournment was:

National Science Foundation Bill — This measure passed the Senate, but House-approved version failed to clear the House Rules Committee and reach the House floor. Both Senate and House versions, virtually the same, were written in manner to meet President's demands when he vetoed science foundation legislation passed last year. Measure may be taken up if special session is called this fall. It is certain to be re-introduced in 1949.

Synthetic Liquid Fuels—House Rules Committee pigeon-holed this bill (H. R. 5475), which would have authorized appropriation of $350 million to establish commercial-sized synthetic liquid fuels plants through RFC loans to private individuals and groups. No action was taken on Senate side where Sen. McCarran (D., Nev.) had introduced an identical measure. Rep. Wolverton (R., N. J.), author of House bill, intends to offer it again next year if necessary.

Natural Gas Act Revisions—Senate Commerce Committee took no action on S. 2757, introduced by Sen. Reed (R., Kans.), to specifically exempt production and gathering phases of Natural Gas Act from regulation by Federal Power Commission. Measure was offered following defeat of Rizley-Moore bill, which would have provided more extensive revisions of scope of FPC jurisdiction. It is expected that Sen. Reed will again offer bill in new session.

• • •

MISCELLANY

Hutex Oil & Refining Co.'s 1000 b/d plant at Hardin, Tex., was shut down June 8 following a fire which destroyed all storage tanks and products. Refinery itself was undamaged and is expected to be back on stream as soon as storage can be rebuilt.

Union Oil Co. of California was another fire victim last month. An explosion in a low pressure evaporator tower damaged one of two 25,000 b/d thermal cracking units at Union's Wilmington refinery June 2. Plant manager Kenneth Kingman said an accumulation of vapors and air may have caused the blast.

Crude topping operations at the plant were not affected, but company officials estimated that one month to six weeks would be required to return the damaged thermal unit to full operation. The other thermal cracker was undamaged.

Increased gasoline taxes went into effect in Louisiana last month. The new state tax on motor fuel is 9c a gal., instead of the previous 7c. This amount, added to the federal tax of 1.5c, makes the total gasoline tax in Louisiana 10.5c a gal.

HORTONSPHEROIDS and NATURAL GAS

In shape, in construction, in operation—the Hortonspheroid is a "natural" for natural gasoline storage. The Hortonspheroid's shape enables it to resist most efficiently the internal pressures created by stored volatile liquids. Its operation is simple and dependable, without moving parts, and does not require operating personnel. It prevents excessive "standing" losses, reduces filling losses, and protects the quality of the stored liquid.

The 100,000-bbl. noded-type Hortonspheroid shown above is located at the Warren Petroleum Corporation terminal at Texas City, Texas. It is designed to operate at a pressure of 15 lbs. per sq. in.

Hortonspheroids are built in standard capacities from 2,000 bbls. to 120,000 bbls. with working pressures from 2½ lbs. to 30 lbs. per sq. in., and are used to store liquids ranging in volatility from motor gasoline to natural gasoline.

If you would like to know more about the design and use of the Hortonspheroid, write our nearest office for a copy of Bulletin E.

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Tulsa, 3 ..... 1620 Hunt Bldg.
Houston, 2 ..... 2130 National Standard Bldg.
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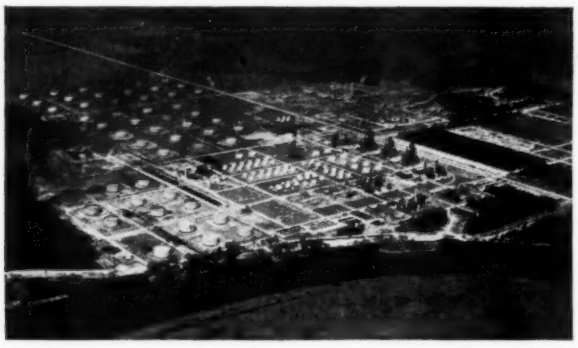


The "Master" Contract – GOOD OR BAD?

EVEN before the last war, a definite trend seems to have been established which has become accelerated in recent years—in favor of the so-called "master" contract.

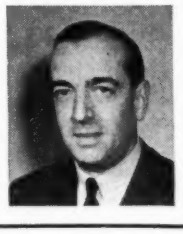
Under this type of contract *all* engineering and construction work to be undertaken at any particular refinery site is placed with *one* engineering contractor—instead of being distributed among several.

From our experience—in the building of complete domestic refineries at Denver, Lake Charles, Salt Lake City and currently at East Chicago, Indiana, plus complete foreign installations made in Palestine and currently contracted for in Brazil, Canada, Argentina and the British Isles—there *are* definite and direct advantages in this method of operation which are probably the reason for the increasing number of "master" contracts being let.

For instance, the "master" type contract offers to the refiner—big or small,

1. ***Concentration of overall process responsibility***
   ... with consequent increase of efficiency of final plant and more profitable employment of refiner's own staff
2. ***Integrated process planning***
   ... providing actual initial capital savings and continued improved operating efficiency
3. ***Coordinated mechanical engineering***
   ... eliminating costly hours of coordinating time and job site alterations
4. ***Uniformity of engineering specifications***
   ... providing economy in maintenance and spare parts inventory
5. ***Centralized purchasing of materials and equipment***
   ... permits allotment of scarce materials in accord with desired completion schedule
6. ***Simplified field administration and accounting***
   ... removing the necessity of duplicate facilities by several contractors in the field and the concurrent extra work at home offices
7. ***Elimination of competition for local labor***
   ... expediting construction and insuring minimum labor costs
8. ***Uniform labor policy at job site***
   ... with resultant improvement of man-hour efficiency
9. ***Maximum economy in use of all labor at job site***
   ... through the flexible interchange of crafts from one unit to another
10. ***Saving in temporary facilities at job site***
    ... by dispensing with duplicate utility lines and housing for tools, supplies and labor
11. ***Reduced tool expense***
    ... through full time use of all tools on various units

by
Warren L. Smith
Vice President of The
M. W. Kellogg Co.



In future advertisements in this series, specialists in each phase of refinery engineering and construction will discuss in detail each of these advantages accruing to the refiner who selects the "master" contract operation.

Our company—M. W. Kellogg—is completely staffed and equipped for refinery and chemical plant design and construction, from the step of laboratory research through the initial operation of completed plants. It periodically issues a publication called the KELLOGGRAM, which describes many of these services. If you are not already receiving it, we will be glad to add your name to the list if you will just drop us a line at 225 Broadway, New York 7, N. Y.

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TOMORROW

... IN PETROLEUM TECHNOLOGY

Current technological and economic developments discussed here in the light of their future bearing on petroleum refining operations include:

- **Power alcohol still considered far from a dead issue.**
- **Middle East oil seen as more important than synthetics.**
- **Petroleum companies highly active in synthetic detergents fields.**
- **Combination oil-gas burner highlights attention to fuel dilemma.**
- **Gas turbines to be employed in British automobiles.**

Power Alcohol Far From a Dead Issue

CLAIMS OF MANY of the power alcohol "alky-gas" adherents have a way of straying from the narrow road bordered by known technology and economics. For example, it was inevitable that a recent article on the subject(1) would evoke answers(2) from those who dislike seeing statistics used to prove a point when those statistics are neither correct nor properly employed.

However, not all of those concerned with this subject are so imbued with a crusader's zeal that they refuse to face the facts. In a recent paper(3) on this subject, G. E. Hilbert, director of the U. S. Department of Agriculture's Northern Regional Research Laboratory at Peoria, Ill., points out the unassailable facts that domestic grain production, even if fully employed for the purpose, could supply only a fraction of fuel demands; that "new inventions which would bring the price of alcohol produced from dollar corn down to the present price of gasoline are beyond the realm of possibility and the capacity of the scientist and technologist. . . .

"To be competitive, alcohol, when used as a blend, would have to sell at essentially the same price as gasoline," which would require subsidization "unless the petroleum industry voluntarily decided to use alcohol and pass the cost along to the customer"(!)

Alcohol-water injection, however, may be a different story from a technical and economic viewpoint, and it is not impossible that the petroleum industry may shortly be very grateful for this alcohol-using way of obtaining the equivalent of the hard-to-get extra octane numbers needed for future high-compression engines. "Alcohol from dollar corn may well be competitive with gasoline if the alcohol is used by direct injection."(3)

Meanwhile, the petroleum industry is watching with interest all reports on alcohol-water injection. "Dollar corn" may not be available again for many years—never, perhaps, if depressions can be avoided—but sufficient alcohol from other sources can probably be made available if the method proves sound.

Middle East Oil Seen Of Immediate Importance

Whether or not the petroleum industry (with or without Federal Government backing or subsidy) or the Government itself decides to rush into being a full-scale synthetic fuels industry, or is pushed into such a decision, remains to be seen. In the interim—and it may be a long one—other means of securing oil are of more immediate interest to the petroleum industry, hard pressed for oil as it is. Among these alternatives is the importation of oil from the Middle East, and for this reason some recent remarks of the newly-elected president of Gulf Oil Corp., Sidney A. Swensrud, are of particular interest, since Gulf is one of the major companies engaged in Near-Eastern production.

Mr. Swensrud's paper itself is not at hand, but the following are some of the remarks quoted from it in a chemical journal:(4)

"The western hemisphere at present has a surplus of oil production. But estimates of future production and needs, barring some unexpectedly huge new discoveries in this hemisphere, show that this surplus probably will disappear about 1951-52. By 1955 the hemisphere would be needing to receive half a million barrels a day from the eastern hemisphere (mostly the Middle East).

"As far as the U. S. is concerned, by 1951 it will most likely be having to receive over half a million barrels a day net imports from the outside; and by 1955 it will probably need upwards of a million barrels daily." Half or more of this will have to come from the Middle East "in all probability," since no more than half can be expected from South America.

"Because of staggering costs involved, there is little probability (according to Swensrud) that synthetic plants, producing oil from gas, coal, or shale, could make any substantial contribution to this million barrels a day shortage by 1955. . . . The plants alone to produce a million barrels daily of synthetic liquid fuels from coal probably would cost upwards of $8 to $10 billion.

"On the other hand, Middle East crude can be produced and brought to this country through modern pipelines and large, fast tankers at an economical cost. Such pipelines and tankers, and the conventional refining capacity required to bring to this country and to process a million barrels of Middle East oil would involve a capital outlay in the neighborhood of $2½ billion, and no new technical problems would be involved."(5)

There is no doubt in any reasoning person's mind that neither synthetic fuels nor oil imports are single answers to the problem of future oil supply. Fortunately, they are not mutually exclusive, so it is quite likely that resort will be made to both, in a proportion which only the future will reveal.

Petroleum Companies Highly Active in Synthetic Detergents

Recent mention(5) that Shell Chemical Corp. is constructing a plant at Wood River, Ill., "for making oil-derived synthetic detergents" serves again to call attention to petroleum industry activity in the synthetic detergents field, a participation clearly delineated in two recent articles on this subject.(6, 7)

The first of these articles describes in some detail the various synthetic detergents now being produced from

(1) W. J. Hale, "We Need An Agricultural Policy," *Chemical and Engineering News* 26, No. 11, 743, 806 (1948).

(2) B. M. Pilhashy, "Facts *vs.* Figures," *Chemical and Engineering News* 26, No. 18, 1317 (1948).

(3) G. E. Hilbert, *Alcohol From Agricultural Sources As A Potential Motor Fuel*, Paper presented at 13th Annual Chemurgic Conference, Omaha, March 3-6, 1948.

(4) Swensrud, S. A., "Importance of Near-Eastern Petroleum," *Chemical Engineering* 55, No. 5, 228, 290 (1948).

(5) Anon., "Shell Builds Detergent Plant," NATIONAL PETROLEUM NEWS 40, No. 22, 22 (1948).

(6) Weil, B. H., "Detergents from Petroleum," *Petroleum Refiner* 27, No. 5, 126-33 (1948); Georgia Institute of Technology, Engineering Experiment Circular No. 22, (1948).

(7) Sittenfield, M., "Economic Outlook for Synthetic Detergents," *Chemical Industries* 62, No. 4, 584, 585, 650, 652, 658 (1948).

petroleum, including those potentially derivable from Synthine intermediates. Chief among these on a quantity basis are the alkyl aryl sulfonates; in addition to such chemical companies as National Aniline, Monsanto, and Sharples Chemical, several petroleum companies are among the leaders in this field—Oronite Chemical Co. (Standard of California subsidiary), Atlantic Refining Co., and (potentially) Standard of Indiana. It is probable that the above-mentioned plant of the latter company will produce detergents of this type.

Many petroleum companies are numbered among the producers of petroleum sulfonate detergents, another important type—Humble, Shell, Texas, Sinclair, Standard of Indiana, Standard of New Jersey, and Sun. Most of these companies, however, produce materials (by direct sulfonation of petroleum fractions or extraction from by-products from sulfuric acid refining) which are "surface-active agents" rather than general-purpose detergents, and the sodium alkyl sulfonates—excellent detergents which fall into this "alkyl sulfonate" class—are at present produced from petroleum only by such chemical companies as du Pont.

In recent years, soap production has varied from 3,273,000,000 lbs. in 1944 to 2,792,000,000 lbs. in 1947, dipping below the latter figure in 1946. Production of synthetic detergents, however, has climbed to the point where 1948 production capacity has been estimated at 700,000,000 lbs. (on a 33% active-material basis, that commonly employed). Sittenfield[7] and Weil[6] both point out that many detergents are currently able to compete with soap only because of the present high prices for fats and oils, raw materials for the latter substance, and state that these high price levels will probably not be indefinitely sustained. However, both feel that those detergents which do survive when price competition becomes acute will largely be those derived from petroleum and Synthinate materials, and that several of these have a very good future.

Combination Oil-Gas Burner May Relieve Fuel Shortages

According to a recent news item,[8] the Midwest Research Institute has developed a combination oil and gas burner for home heating use, in a project sponsored by a Cities Service subsidiary. Gas is the prime fuel for this burner, and "is burned in a conventional manner," but the unit is switched to oil by an outside thermostat "whenever outdoor temperatures drop below a predetermined point at which gas pressure may be expected to fall off," because of mounting demands.

Oil is burned in these units "on the vaporizing principle, with the addition of a small gas flame beneath the vaporizing pan, although it is claimed that it can be operated even though the gas supply should fail entirely." Burner efficiency is claimed to equal existing types burning both fuels, and "manufacturing estimates indicate the unit can be produced and sold at prices competitive with oil burner prices." The Midwest Research Institute reportedly will license the burner on a "liberal and non-exclusive basis."

Some 25 units were operated in homes during the past season, with reportedly satisfactory performance. Oil consumption amounted to 10-25% of the total season's fuel requirements.

Large-scale use of such burners would "relieve both the severe gas shortages during (and caused by) cold waves and the peak delivery problems of fuel oil distributors." However, even if their manufacture and sale reach sizable proportions, it will be a number of years before their influence can be felt. Such developments are well worth the effort involved, and in the aggregate help to solve difficult problems, but they are somewhat like waves beating against a granite cliff. It therefore behooves the petroleum and gas industries to continue and to increase their other efforts to get sufficient quantities of fuel to markets to meet anticipated peak loads—efforts quite likely to meet with success in a few years if an impatient public and certain political demagogues do not previously "upset the apple cart."

In this connection, statements made before the 1948 Joint Production and Chemical Committee Conference of the American Gas Association at Asbury Park, N. J., May 24-26, indicate that the gas industry is fully aware of its problem. The Long Island Lighting Co., for example, has found that catalytically-cracked liquefied petroleum gases can be added to manufactured gas in practically all proportions, as compared with butane-air mixtures, whose use is limited to about 22% for specific gravity reasons. Other companies are working on "reforming refinery oil gas" with steam, employing a Synthine process variant, and oil-gas continues to receive attention from still other companies, who employ heavy petroleum residues.

Similarly, the petroleum industry, as mentioned, is concerning itself with synthetic fuels, oil imports, increased exploration, and refinery construction. It goes without saying that all involved devoutly hope that their efforts will have the desired result.

Gas Turbines To Be Used In British Automobiles

The petroleum industry, as mentioned last month in this feature, is already vitally concerned with the provision of gas turbine fuels and lubricants for aircraft use, but it is none-the-less interested, albeit academically at present, in the possible use of such products in automobiles.

For this reason, it is more than interesting to note a recent report[9] which states that two British automobile manufacturers are testing full-scale automobiles powered with gas turbines which burn kerosine as fuel.

While the turbines employed "are scaled down from aircraft engines," they differ in one important respect: two turbines are employed instead of one. "The single turbine-wheel in the airplane engine does two jobs: it drives (1) the air compressor that furnishes pressurized air for fuel combustion, and (2) the prop (or its energy is exhausted as a jet-stream).

"In the (British) motorcar designs, one turbine drives just the compressor; a second (on a separate shaft) supplies power to the wheels." One company employs a single combustion chamber, while the other uses "a series of combustion chambers arranged around the engine." Use of two turbines instead of one is said to be the "key to the successful transformation of the aircraft type (turbine) to auto use," since "the torque characteristics of the single-turbine type of aircraft gas turbine aren't suitable for use in an automobile engine. This is true because at low speeds the compressor absorbs most of the torque, even though the engine can furnish high torque at low speed.

"In the two-turbine type, the compressor unit operates independently of the vehicle's load and power requirements. Thus, the power-turbine, on its own shaft, can develop its normal high torque at low speeds. This scheme does away with all gear changing except reverse."

Gas-turbine automobile engines have challenging weight-saving, fuel-economy, and ease-of-maintenance potentials, although "plenty of problems in materials and processing exist," including the scaling down of turbine blades, which have "precision contours and close dimensional tolerances"—and would be about the size of a dime in an automobile engine. At present, "high fuel consumption" is listed among the problems, indicating that fuel economy has not yet been realized. Nevertheless, the first steps have been taken toward the commercial use of gas turbines as automobile engines, and it may well be expected that others will follow the beaten path or seek routes of their own.

(8) Anon., "Combination Oil-Gas Burner Developed for Home Heating," NATIONAL PETROLEUM NEWS 40, No. 22, 35 (1948).

(9) Anon., "Gas Turbines for Autos," *Business Week*, No. 978, 66, 68 (1948).

MONEL-CLAD

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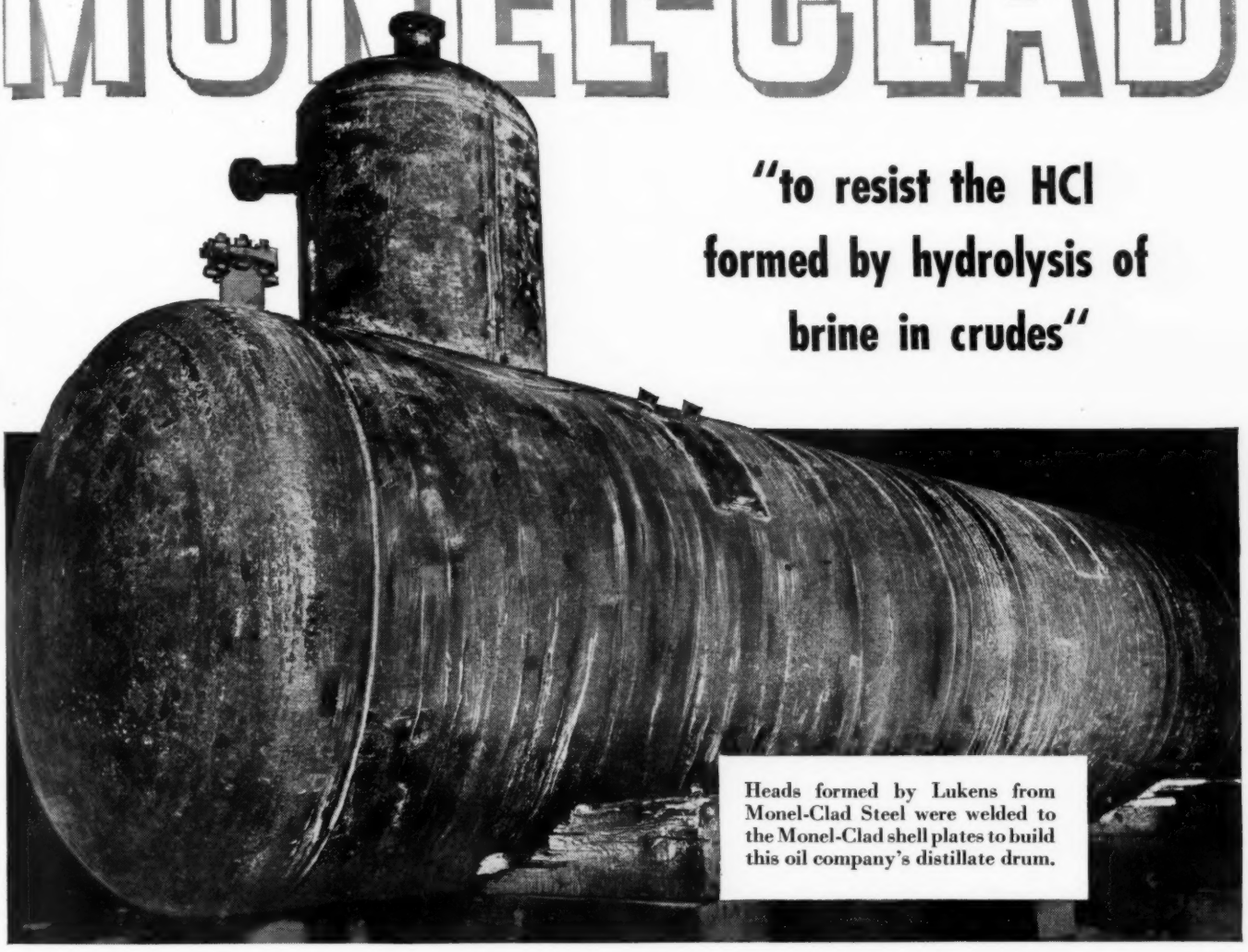

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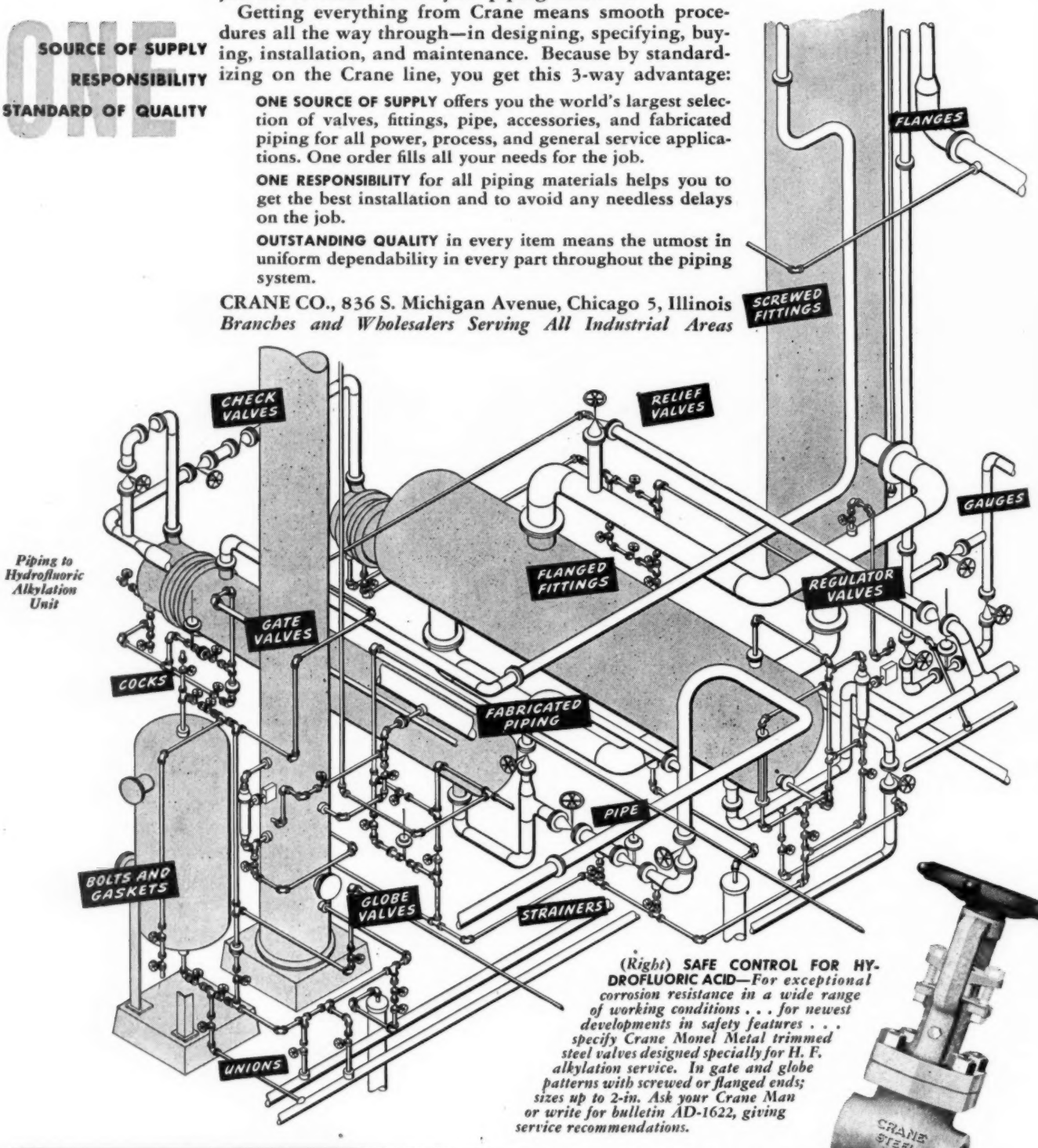

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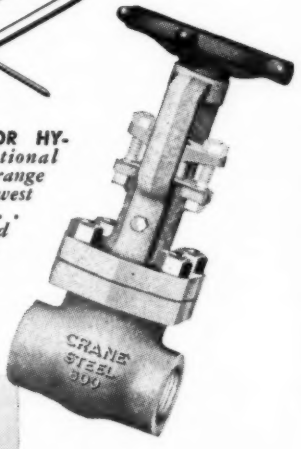

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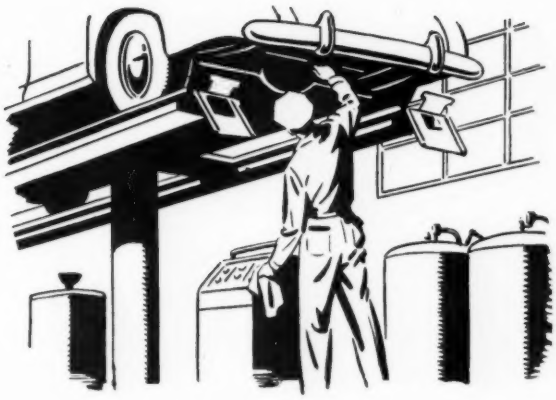

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A report on the most useful year

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1 **World-wide, the need for oil surpassed all records.** To help meet the need, crude oil production by Jersey Company affiliates was increased 8% over 1946, setting another new record. Their production was 14% of the world's total for the year.

2 **In the U.S., too, the need was at record levels.** Three million more cars to fuel than pre-war; twice as many tractors and trucks on farms; a million and a half more oil-heated homes; five times as many diesel locomotives. Total U.S. consumption of oil products was 11% greater than 1946, 12% greater even than the peak war year. In meeting this need, we set new output records month after month, accounting for 9% of U.S. total crude oil.

3 **The unusually hard winter** made heating oil and kerosene supply a special problem. By extraordinary effort in refineries and hard work and long hours by people all along the line, we were able to deliver about 25% more of these products than in the winter before.

4 **With such big demand, big supply, and rising prices,** money came in — and was paid out — in all-time record figures. Total dollar income reached $2,387,000,000 — 45% over 1946. Operating charges and other deductions from income reached $2,118,040,000 — 44% over 1946. A record sum of $466,954,000 was paid to our employees.

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5 **Net consolidated earnings** of the Company and affiliates — $269,000,000 — equalled $9.83 per share, or 11.3% of total income as compared to 10.8% in 1946. Dividends of $4.00 per share were paid by the parent Company.

6 **Most important dollar figure of the year** was the 426 million dollars spent for new wells, plants, tankers, pipelines and all the other things it takes to get the oil you need. Part of a billion dollar program covering the two years 1947-48, it was by far the greatest capital investment we have ever faced. The money came almost entirely from earnings, past and current — money made on the job went back into the job.

7 **Transportation of oil was a big job.** During the year, we bought 23 ocean-going tankers from the U. S. Maritime Commission, and early this year we ordered 6 new 26,000-ton, 16-knot ships, the largest we ever operated. Pipelines were pushed to new records — our trunk lines delivering 83 billion barrel-miles, or 11 billion more than in 1946.

8 **In discovering new oil,** we spent 5 times as much as pre-war — 16% more than last year. (Altogether, the country's known oil reserves were increased by 600 million barrels during the year, in spite of record consumption.)

9 **Cost of research also increased** — $18,200,000 was spent for new knowledge. Considerable progress was made in finding more efficient and lower-cost processes for making gasoline and other liquid fuels synthetically from natural gas, oil shale, and coal.

10 **Labor-management relations** remained excellent, continuing our exceptional record of industrial harmony. Employee compensation was adjusted upward during the year to help meet rising living costs. A total of $55,396,000 was saved in employee Thrift Plans, of which $20,987,000 was saved by employees and $34,409,000 contributed by the Company and its affiliates.

THE 1947 JOB WAS A BIG ONE. The jobs ahead are bigger still. In a democracy the responsibility for making a better world rests with the individual and the individual enterprise. It is clear that an enterprise like Standard Oil Company (New Jersey) must exercise a full realization of the social responsibilities of profit—must understand that the peace, advancement, and the security of the people of the world are the best guarantee of the Company's own progress and security. We intend now, as always, to demonstrate in action that the free, competitive American enterprise system is far superior to any other. We believe that the Company and its affiliates are so organized, and their business so conducted, that they will continue to serve people well.

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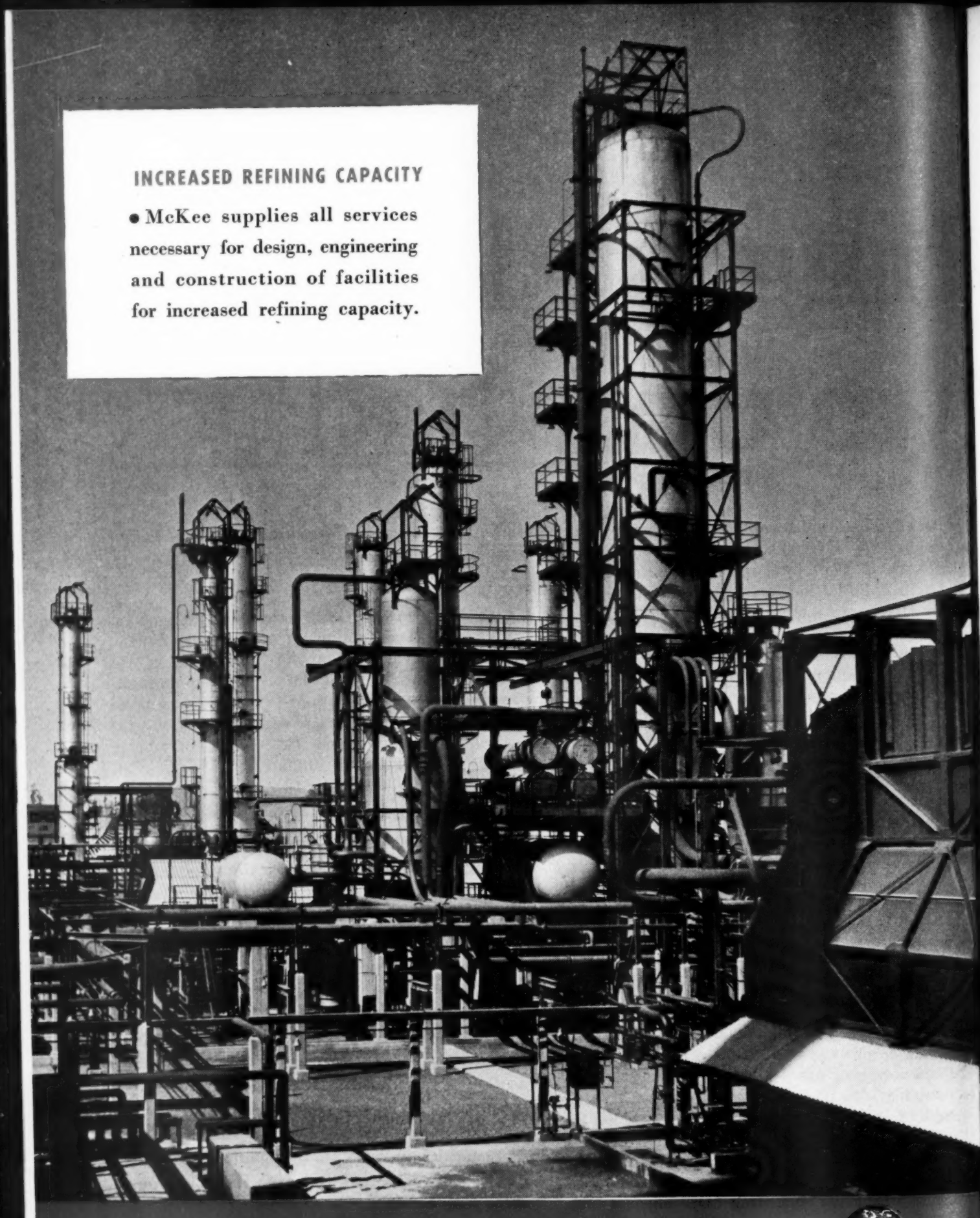
Copies of the full report are available on request. Address Room 1626, 30 Rockefeller Plaza, New York 20, N. Y. The earnings statement in this report satisfies the provisions of Section 11 (A) of the Securities Act of 1933.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Design Details, Operating Results Of First Commercial Hypersorber

By WILLIAM F. BLAND
Engineering Editor

RECOVERY of over 98% of high-purity ethylene from a feed gas which contains less than 6% of this hydrocarbon is being achieved by Dow Chemical Co. at its Midland, Mich., plant using the recently-developed Hypersorption process.

Dow's Hypersorber is the first commercial unit of its kind to be built, and has been operating successfully for over a year. A second commercial unit has been built for a leading chemical company in the southwest, but no details of its operation have been released as yet, although it was scheduled on stream some weeks ago.

The Hypersorption process was originally developed by Union Oil Co. of California. Essentially it is a fractionation method for the recovery of hydrocarbons from lean gas streams, employing a moving bed of activated carbon. It is based upon the property of activated carbon to absorb selectively volatile hydrocarbons, with the selectivity being dependent upon the temperature of the carbon and the molecular weight of the hydrocarbons.

Dow's Ethylene Operations

Dow has been operating an ethylene recovery plant at Midland for some years, using the ethylene as the basic raw material in the manufacture of such chemicals as ethyl benzene, ethyl chloride, ethylene glycol and ethylene dibromide. Conventional low-temperature fractional distillation has been employed in the past for recovery of the C_2's and other light hydrocarbons. Feed gases for the plant are obtained from Michigan crude, which is highly cracked to secure maximum ethylene yield.

Several years ago, with ethylene demands increasing considerably, Dow looked around for new sources of this essential raw material. Crude oil wasn't as scarce an item then as it now is—and was the first obvious source. The Midland gas recovery plant, however, was already operating at capacity, and to handle any more cracked crude new facilities would have had to be added.

Another likely source was the demethanizer overhead stream from the existing recovery plant. Although that overhead stream contained essentially hydrogen and methane, it also included a goodly amount of the desired ethylene—5 to 7%. The hitch was that recovery of that last 5 to 7% was at best a marginal operation, and in the past it had been used as fuel for gas engine-driven compressors around the plant.

It was also about that time that Union's Hypersorption process began to emerge from the pilot plant stage as a commercial possibility. Dow had been studying the process, considering its application in its own operations. The possibility of applying it to the demethanizer overhead gases seemed to offer a chance to solve two problems—first, to try out the process on a small scale; and second, to recover economically that marginal percentage of elusive ethylene.

Another advantage that Dow saw was that the Hypersorption unit could be built and put into operation in a much shorter period of time than additional low-temperature fractionat-

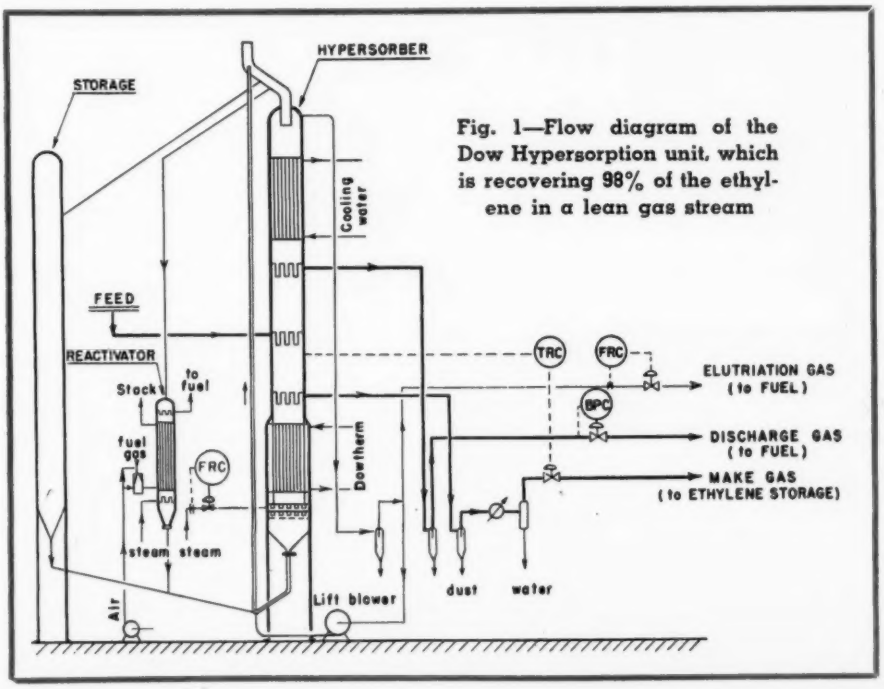


Fig. 1—Flow diagram of the Dow Hypersorption unit, which is recovering 98% of the ethylene in a lean gas stream

ing facilities. Dow subsequently contracted with Union Oil Co. and Foster Wheeler Corp. to design and erect a Hypersorber with a daily capacity of 1,800,000 SCF of feed gas. The unit was put on stream in May, 1947 and has been operating since then with only minor interruptions.

Flow Through Dow Unit

Fig. 1 shows a flow diagram of the Dow unit. It consists essentially of the Hypersorber or adsorption column, lift line, carbon reactivator and a storage bin, plus auxiliary facilities. The adsorption column contains two major heat transfer sections—a cooling section at the top and a stripping section at the bottom—with the adsorption section in between.

Major auxiliary facilities are a centrifugal blower for supplying lift gas to circulate the carbon through the system, and a Dowtherm boiler for supplying heat to the stripping section. Other auxiliaries include cyclone dust collectors to remove carbon fines from gas streams leaving the adsorber, steam condenser on the product line, and product dryer.

In operation the feed gas stream, piped directly from the demethanizer column, is introduced about midway in the tower. It moves upward in contact with and countercurrent to the activated carbon bed, which flows downward through the tower. At the temperature which is maintained at the feed point (about 140° F.) the carbon selectively adsorbs the ethylene and other gases of similar or higher molecular weight.

The unadsorbed lighter components, consisting predominately of methane and hydrogen, pass on upward and are removed as discharge gas at a disengaging plate located just below the cooling section at the top of the tower. The discharge gas is then used around the plant as fuel.

The adsorbed gases, mostly ethylene, pass downward with the carbon and into the stripping section. Here the temperature of the carbon is increased to about 510° F. by means of the Dowtherm system, at which temperature the adsorbed gases are desorbed from the carbon. These pass back up the tower and are removed as make gas at a second disengaging tray situated just above the stripping section.

Not all of the gases released in the stripping section are removed immediately as make gas. A small portion of them continue on up past the disengaging tray and serve as reflux in the section of the tower immediately below the feed tray, serving to liberate any lighter components which may contaminate the adsorbed material.

Steam (150 psig) is introduced below the stripping section to remove the last traces of adsorbed gases, particularly the heavier ones, and passes upward and out with the make gas. This steam is condensed out in a cooler, and the make gas finally passed through an alumina dehydrator to remove any remaining traces of moisture from the product.

Carbon leaves the base of the tower and is moved back up to the top through a 10-in. diameter pipe. Gas pressure for lifting the carbon, at a rate of 15-20 ft./sec., is supplied by a centrifugal blower. A sealing leg at the bottom of the tower prevents stripping steam from passing into the lift section.

At the top of the tower the carbon is dehydrated and passes into the cooling section, where its temperature is dropped to about 120° F. The cycle is then repeated on a continuous basis.

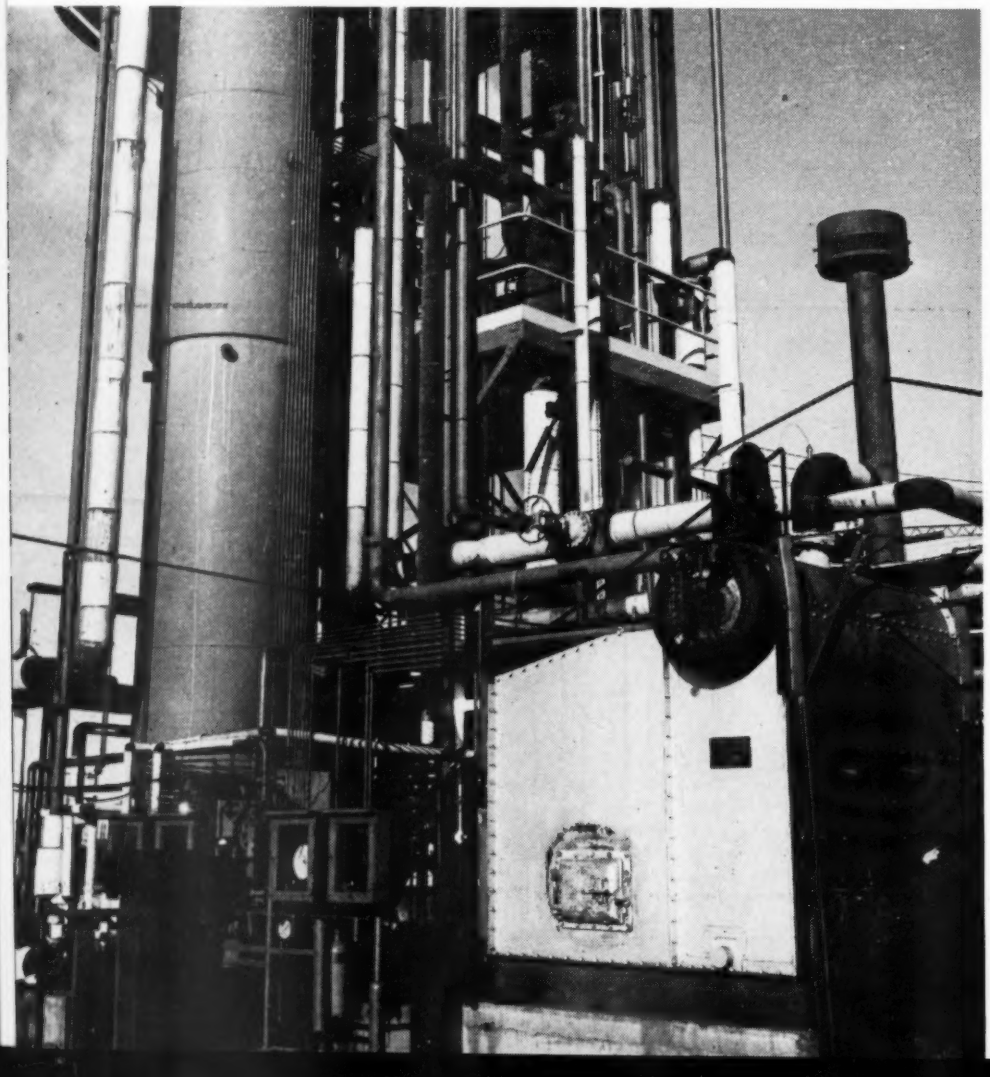
In order to keep the system free of an excessive amount of fines, a portion of the unadsorbed gases is permitted to pass up the tower past the cooling section as purge gas, its velocity being such as to carry with it any carbon particles of 60 mesh or finer.

This purge or elutriation gas is then withdrawn at the top of the tower and goes to fuel, together with the discharge gas. A portion of it, however, provides the necessary lift gas to circulate the carbon.

Composition of the feed, product, discharge and purge gases for a period of normal operation of the unit are given in Table 1.

Operation of the unit has been even more satisfactory than was expected, according to Dow engineers. Although designed to yield an ethylene product stream of 91% purity and containing 1.1% methane, it has been producing a stream of 92-93% purity and with only 0.1% methane. On a CO_2-free basis, the product stream contains 95.2% ethylene, and 99.9% C_3's.

Recovery has also been higher than expected—98% compared to a design



View of the lower section of the Dow Hypersorber, with a closeup of the Dowtherm boiler, which supplies heat to the tower for stripping off the adsorbed ethylene. This application of the Dowtherm boiler for heating is somewhat unusual, and has several advantages. It gets away from direct firing or a high pressure steam system, it eliminates the need for a circulating pump, and it maintain a more uniform temperature

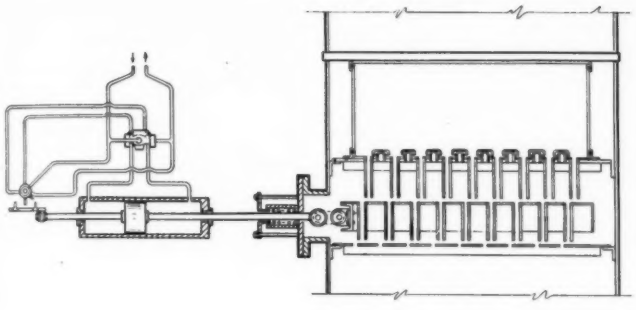


Fig. 2 (left)—Sketch of the shaker device which controls the rate of flow of carbon through the tower, with a photograph above it of the oscillating shaker tray

Fig. 3—(above)—Discharge gas disengaging tray which permits removal of the unadsorbed light gases from the activated carbon

figure of 96%. Maximum ethylene content of the discharge gas during normal operation has been 0.1%.

Carbon Reactivation

Facilities are provided in the Dow installation to reactivate the carbon by continuously withdrawing a small portion of it from the system and stripping it with high temperature steam. This stripping action is designed to remove any accumulation of heavy residual hydrocarbons, which if left on the carbon would lower its adsorption properties.

In actual practice Dow has found that reactivation is not necessary in its own operations. In fact, the reactivator has not been used since the unit was put on stream. This is occasioned by the fact that the feed gas used in the Dow unit has already been closely fractionated and no longer contains any heavy material capable of fouling the carbon—at least none which can't be removed in the usual operating cycle.

However, even though the reactivator has not been used since the unit was put on stream, Dow's engineers feel that it is a good insurance investment. There's always the possibility, they say, even though remote, that the fuel gas might accidentally include some heavier hydrocarbons at some time.

Carbon Losses

About 14,000 lbs. of 12-30 mesh activated carbon is used in the Dow unit, and during operation a certain amount of loss can be expected, due primarily to attrition in moving the carbon through the system. Whenever the level of carbon in the top of the unit falls below a certain minimum point, as indicated by control instruments, the operator manually opens a valve at the bottom of the storage bin (which operates at the same pressure as the Hypersorber—75 psi) and adds sufficient fresh carbon to raise the level to the desired maximum point. Addition of carbon is necessary about every two or three days.

Carbon losses in the Dow unit are running about 90-100 lbs./day. Although this loss is higher than pilot plant studies by Union Oil Co. indicate could be expected, it is not excessive in Dow's case.

Union's studies have been carried out using a cocoanut grade carbon, which has a high rate of activity and also high strength. This material was selling in the neighborhood of $1 a pound at the time Dow was readying its unit for operation—and represented a sizable investment. Dow located a quantity of less expensive carbon which was available at about 7c a pound. Its activity and strength, although not as high as the cocoanut grade, were entirely satisfactory, and the difference in price more than offset the increased losses that could be expected.

Details of Construction

The main Hypersorber tower is 4½ ft. in diameter and about 85 ft. high. The storage section is 4 ft. in diameter and about 60 ft. high. Each is self-supported on skirts. Since the feed gas normally contains only noncorrosive compounds, no particular attention had to be paid to corrosion resistance and carbon steel was used throughout.

Rate of flow of carbon through the system is controlled by a shaker plate located just below the stripping section. As shown in Fig. 2, the device consists of two fixed plates and a movable one sandwiched between them, providing a positive displacement type of control mechanism. About ¼-in. clearance between plates prevents grinding of the carbon.

The movable tray oscillates, and has a number of downspouts which serve as pockets for moving the carbon. When in one extreme of its position, alternate downspouts of this tray are in position to be filled by

TABLE 1—Composition of Feed, Make, Discharge, Purge Gases*

Component	Feed Gas		Make Gas		Discharge Gas		Purge Gas	
	SCFH	Vol-%	SCFH	Vol-%	SCFH	Vol-%	SCFH	Vol-%
Hydrogen	29,400	39.8	....	....	14,200	31.6	15,200	61.8
Nitrogen	1,240	1.7	....	....	630	1.4	610	2.5
Carbon Monoxide	670	0.9	....	....	350	0.8	320	1.3
Oxygen	100	0.1	5	0.1	45	0.1	50	0.2
Methane	37,900	51.3	....	....	29,600	66.1	8,300	33.7
Carbon Dioxide	150	0.2	130	2.9	.....	....	20	0.1
Acetylene	160	0.2	160	3.6	.....	....	.....	....
Ethylene	4,250	5.8	4,150	92.7	.....	....	100	0.4
Ethane	30	Trace	30	0.7	.....	....	.....	....
TOTAL	73,900	100.0	4,475	100.0	44,825	100.0	24,600	100.0

* Gas samples were taken during a 48-hr. period of normal operations. Analyses were made with both mass spectrometer and combustion orsat.

the delivery tubes in the fixed tray above. These pockets do not discharge, because in this position they are sealed by the fixed tray below. As the tray moves to the opposite extreme in its travel these downspouts pass into position over discharge holes in the tray below and are emptied.

When operating under design conditions, the Dow unit circulates carbon at the rate of about 18,000 lbs./hr. Flow can be increased or decreased by changing the rate of movement of the oscillating shaker plate, which is hydraulically operated.

The engaging and disengaging trays are designed so as to be symmetrical across the area of the unit,

General view of the Hypersorber, with the main Hypersorber tower at the left and the storage bin at the right. The Dowtherm boiler is in the foreground at the right

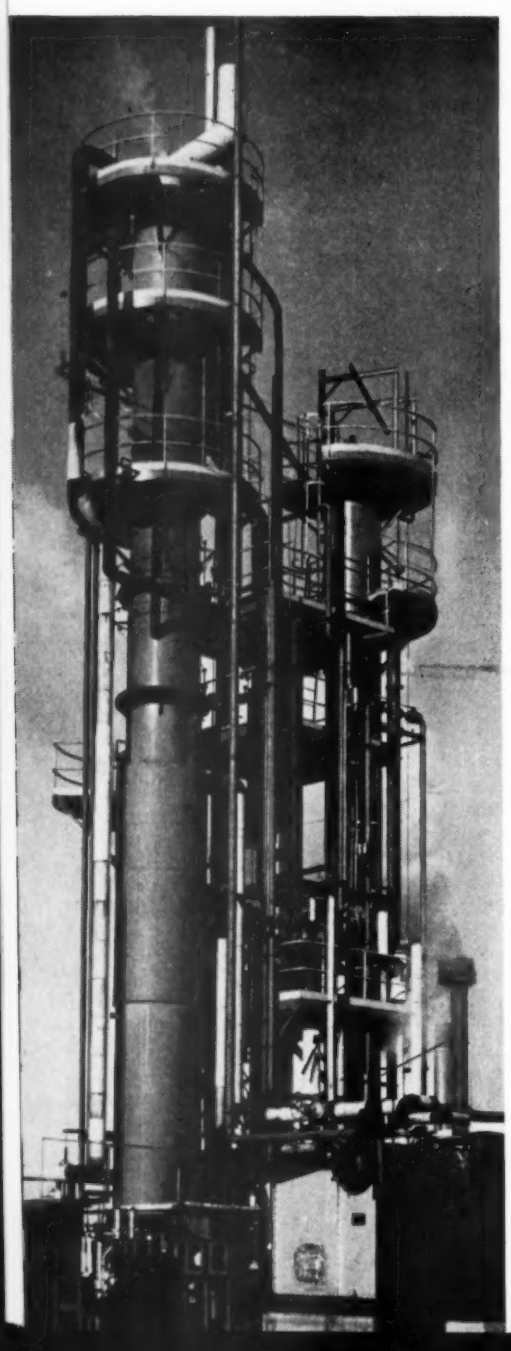


TABLE 2—Utility Requirements of the Dow Hypersorption Unit Operating Under Design Conditions

(Feed, 75,000 SCFH; Carbon Circulation, 18,000 lbs./hr.; Pressure 75 psi)

Cooling Water (20° F. temperature rise), gpm:		
Hypersorber cooling section	135	
Make gas cooler	55	
Lift gas blower seal	2	
TOTAL Cooling Water, gpm		192
Fuel Gas (minimum 800 BTU/SCF): SCFH:		
Dowtherm boiler	2950	
TOTAL Fuel Gas, SCFH		2950
Steam (150 psig), lbs./hr.:		
Stripping steam to Hypersorber	400	
Gas lift steam turbine drive	960	
TOTAL Steam, lbs./hr.		1360
Electricity, KW:		
Water booster pump (to cooling section)	2.5	
Hydraulic pump for carbon shaker tray	3.5	
Lights, instruments and controls	5.0	
TOTAL Electricity, KW		11

permitting virtually uniform vertical downward movement of the carbon. They consist of circular plates having symmetrically placed downspouts through which the solids pass and under which the gases are permitted to engage or disengage. A ring tube containing a number of inlet or outlet ports is employed at each plate for distributing or collecting the gases. A view of the discharge gas disengaging tray is shown in Fig. 3.

Utility Requirements

Utility needs of the unit are relatively low. When operating under design conditions of 75,000 SCF/hr. of feed gas and 18,000 lbs./hr. carbon circulation, the entire operation requires only 192 gpm of cooling water, 2950 SCF/hr. of fuel gas, 1360 lbs./hr. of 150 psig steam, and 11 KW of electric power. These requirements are expanded and itemized in Table 2.

Labor needs are also low—with one man per shift spending only about half his time on the unit.

Operating Problems

Several operating difficulties were experienced and overcome on the Dow unit. Probably the most troublesome was erosion in the centrifugal blower for the lift gas. After the unit had been operating for some time, it was discovered that fine particles of carbon were doing a splendid job of sand blasting the interior of the blower case—to the point where they actually came through in one spot.

This situation was corrected by running the purge gas through a cyclone dust collector before the lift gas stream was drawn off. With a dust-free lift gas the trouble seems to have been corrected.

Difficulty was also experienced with thermal expansion in the lift line, which set up strains in the case of the blower and caused the rotor to rub. An expansion joint solved the trouble.

Probably the most critical point in the operation of the unit, Dow engineers say, is control and maintenance of the carbon level in the bottom of the Hypersorber. If this level is lost—and Dow lost it several times before a satisfactory control method was worked out—stripping steam gets into the lift line and travels with the carbon up to the top of the tower and into the cooling section. There it condenses on the carbon particles and effectively plugs up the entire system. Once this happens, the only solution is to shut down, drain off the cooling water in the top section, and run steam through the cooling tubes to dry out the carbon.

The control device now being used consists of two spark plugs set into the side of the lower section of the Hypersorber tower—one just above the minimum carbon level and the second just below the maximum level. When the carbon approaches the minimum level, contact between the electrodes of the lower spark plug is broken and a relay sets in operation a motor-operated valve which partially closes the opening through which the carbon passes into the seal leg at the bottom of the tower.

With the opening restricted, the carbon level rises. When it approaches the maximum level, contact between the electrodes in the top spark plug is closed and a second relay reverses the motor so that the valve again opens up and permits a greater flow of carbon out of the tower.

Although this method of control has effectively prevented steam from passing into the lift line, it has the disadvantage of being definitely cyclic in operation. Dow engineers are now working on a smoother method of control at this point.

Previous Article

A previous article published in PETROLEUM PROCESSING last year gave further details on the Hypersorption process, together with results of pilot plant studies: "Hypersorption Process for Separation of Light Gases," April, 1947, (Vol. 2, No. 4), pg. 300.

Mechanical Devices Offered as Solution To Octane and Gasoline Supply Problem

By WILLIAM C. UHL
Equipment Editor
PETROLEUM PROCESSING

FRENCH LICK, Ind. — Two mechanical methods for supplying satisfactory fuels for the new high compression automobile engines are proving economically practical, it was reported at the annual Summer Meeting of the Society of Automotive Engineers here June 6-11. The methods, if they were widely adopted by the vehicles on the road, would solve the refiners' problem of producing higher octane fuels for higher compression engines.

While both devices have been previously announced, test data on their actual use was presented in meeting papers and the ensuing discussion at this SAE meeting. The proposed methods are:

1—An automatic device for injection of an anti-knock fluid into the air-fuel stream in carburetors which would enable present engines to operate efficiently on low-octane, straight-run gasoline, and also would permit the new high compression ratio engines to operate on present premium, or even regular, grades of gasoline, instead of requiring 100-octane fuels.

2—A dual-fuel carburetor which automatically meters low or high-octane gasoline from a double fuel tank to meet varying road octane requirements under different driving conditions.

The more efficient utilization of present high octane fuels provided through either method would make it possible for refiners to produce more low octane fuels and thus obtain a greater yield of products per barrel of crude run to stills, it was said.

Octanes Wasted Now

Both systems are based on the fact that automobile power plants need high octane fuel but a fraction of the operating time and will run satisfactorily on low grade fuels most of the time. They were described in technical papers by two petroleum engineers and one automotive equipment engineer comprising a symposium on June 11 that was easily the high point of the SAE week's program. Enjoying the largest attendance of any of the sessions, the symposium was followed by an overtime discussion period in which 10 leading automobile and oil industry technologists participated.

The anti-knock quality of the fluid used in the injection system can be utilized in two ways, according to C. H. Van Hartesveldt, vice-president, Thompson Vita-Meter Corp., in his paper, "Anti-Detonant Injection."

"First, it may be added to low octane number, high burning quality gasoline to give adequate octane number and important maintenance savings to commercial fleets," Mr. Van Hartesveldt said. "Secondly, it can be used with regular and premium grades of gasoline to satisfy the octane requirements of high compression ratio engines. The two applications can increase the yield of gasoline from crude oil and decrease refinery investment needs over the years to come."

Thompson is now in production on the Vita-Meter and will make it available to the public in the fall, Mr. Van Hartesveldt told PETROLEUM PROCESSING. It will cost about $25 and can be installed in any car in about 20 minutes by any service station attendant. The ultimate design and installation of the injector on the new cars is a problem for automotive equipment manufacturers just as it is for all accessories, he said.

The fluid will cost about 30c per gallon, with the average motorist needing about 10 gallons per year. It is planned for refiners to blend the material and handle it through their regular retail outlets. Thompson holds pending patent applications on the fluid. Trade-named "Vitol" it is a mixture of 85% methanol and 15% water, plus 3 cc. of tetraethyl lead per gallon and small amounts of rust and stabilizer additives.

Experience of one oil company in using the injection system was presented at the meeting in a paper, "Use of Anti-Detonant Injection in a High Compression Ratio Engine," by Ray I. Potter, chief, fuels and lubricants service division, Standard Oil Co. (Ohio).

Summarizing results of tests in a stock model engine in which the compression ratio had been increased to 9-1 by Sohio engineers, Mr. Potter reported that miles per gallon with premium grade gasoline could be increased from 19.5 to 22.2 for mixed city and country driving with an average overall consumption rate of 2.9% of the anti-detonant solution to the gasoline used. In the case of ordinary city driving, the improvement was from 15.9 to 19.1 miles per gallon with a Vitol consumption of 8.8% of the gasoline used.

The dual-fuel carburetor, which will feed either low or high octane gasolines to the engine as needed was described in a paper, "Progress Report on the Dual-Fuel System," by W. M. Holaday, director, Socony-Vacuum Laboratories.

Although the utility of a dual-fuel system has not been established beyond question, Mr. Holaday stated that the work so far has shown that

Previous Articles on Fuel Economy

"Cost of Making Higher Octanes," by W. M. Holaday, Jan., 1948, p. 107.

"Higher Compression, Fuel Saving Engine Practical, Kettering Tells SAE," by W. C. Uhl, July, 1947, p. 485.

"More Efficient Utilization of Fuels," by C. F. Kettering, July, 1947, p. 486.

"What Next in Automotive Fuels," by D. P. Barnard, April, 1947, p. 245.

"Better Fuel Economy in Tomorrow's Cars through Surer Control of Knocking," February, 1947, p. 90.

"Alcohol-Water Injection as a Detonation Depressor in Gasoline Engines," by A. T. Colwell, R. E. Cummings, and D. E. Anderson, February 7, 1945, p. R-88.

"Discussion on Alcohol-Water Injection," April 4, 1945, p. R-249.

it is practical and can result in smooth performance. No concrete conclusions have as yet been reached with respect to the most satisfactory octane fuels to use, although some 63,000 miles have been covered by 28 passenger cars representing 10 different makes in the Socony-Vacuum test programs.

Demonstrated in Cars

In addition to hearing the facts presented in the three papers, scores of SAE members took demonstration rides all last week over the rolling Indiana countryside in several late model cars equipped with both the Vita-Meters and the Socony-Vacuum dual-fuel type carburetors.

The anti-detonant-using cars had been sent here by Sohio, Quaker State Oil Refining Co., and Thompson Products Co., parent organization of the Thompson Vita-Meter Corp. Fitted with instruments to show the effects of the treatment under road operating conditions, the cars were given "the works" by both company engineers acting as drivers and SAE members who were urged to "take the wheel."

The Sohio car was a standard current model Chevrolet with the engine "souped-up" to give a 9-1 compression ratio. The Quaker State and Thompson cars were conventional 1948 Buicks with the latest General Motors' 8-1 compression ratio engines. All cars need up to 100-octane gasoline for satisfactory performance, but the injection system permitted them to operate on the road with ordinary grade fuel.

Good up to 2000 Miles

Injected automatically as needed, one gallon of the "Vitol" fluid will last from 600 to 2000 miles, depending on the type of driving, Mr. Van Hartesveldt and Mr. Potter explained. Control of injection is by means of variations in manifold vacuum, which changes with closed, part, and full-open throttle. The cars give up to 18% more power along with 13% more miles per gallon, it was stated.

The cost of the treatment averages to about 2c per gallon of gasoline used, and it gives 10 to 15 incremental road octane numbers. This compares favorably with the cost of refinery methods for increasing octane. The cost of premium over regular fuels is also about 2c but the octane spread is only between 3 and 5 units. Furthermore, the lower octane gasolines' burning qualities result in cleaner engines, Mr. Van Hartesveldt added.

Alcohol Supply Held Adequate

In answer to the question of adequate alcohol supply, Mr. Van Hartesveldt said this presents no problem. "New passenger car production for 1947 was 3,600,000 units compared to a total registration of 31,000,000 . . . 1947 production of methanol of 80,000,000 gallons is expected to increase to 110,000,000 in 1948; 1949 capacity will be about 138,000,000 gallons, and may be extended to 150 million. . . A passenger car equipped with a Vitameter will need about 10 gals. of alcohol per year. Thus it appears that the methanol supply will not be a limiting factor in the early commercial application of anti-detonant injection."

He added that other alcohols can be and have been utilized in test programs, namely ethanol and isopropanol. However, a higher cost per gallon on these materials would reduce the economy of the injection system.

Use Standard Compression

Demonstration cars for Socony-Vacuum's dual-fuel system were two in the upper price bracket, but with engines of standard compression ratios of about 6.5-1. They were being driven on 65-octane gasoline about 75% of the time, switching over automatically to 88-octane fuel as needed. This ratio, however, was due to the rugged treatment to which they were being submitted. It was shown that for the majority of ordinary cruising at any speed, they would operate satisfactorily on the lower grade gasoline with no knocking and no loss of power.

Socony-Vacuum's test program results, as reported in Mr. Holaday's paper, were based on all types of drivers and all types of driving conditions. Average consumption of the high octane fuel for mixed city and country driving was about 16% for a total distance covered of some 56,000 miles. For 700 miles of heavy city traffic it was about 22%, and for 600 miles of mountain runs it reached as high as 52%. Variations between driving habits by individuals showed a range of up to 11 percentage points in the city and country runs.

"Important Milestone"

Engineers taking part in the discussion period after the three papers lauded them all as "important milestones in the road to success in automotive and petroleum joint research."

Dr. D. P. Barnard, research coordinator, Standard Oil Co. (Indiana), called the symposium a most important step in the direction of meeting the double problem of higher compression and higher octanes. He suggested the possibility that the automobile industry could reduce the steel they use in cars, making them lighter by perhaps as much as half a ton, and make this steel available to the oil companies to make more gasoline. Such a step would have a two-fold result, he pointed out. It would give the oil refiners some of the steel they need and at the same time it would reduce the car's weight-to-power ratio, resulting in a gain of efficiency. Dr. Barnard is the recently elected president of the Coordinating Research Council, which body directs the joint research work of the two major industries. He also emphasized that the oil industry is having difficulties with the present supply of steel just for replacement and maintenance without even considering the needs for expansion.

Petroleum Situation

A. T. Colwell, vice-president, Thompson Products, and chairman of the SAE executive committee, said: "Dan Barnard has put his finger on the real discussion here today—the petroleum situation—not just high compression engines and high octane savers."

The ideas behind both dual-fuel and the injection systems are technically sound and practical, he said. However, human nature may yet give us a lot of trouble. Motorists may start putting high grade fuel into both tanks, or they may get tired of feeding small amounts of fluid to a little tank under the hood.

Increases Reserves 30%

"But I will say this: if the use of either method saves us only 15% as expected in fuel, it will be a tremendous stride and mean the equivalent of increasing the petroleum reserves as much as 30%, because the car manufacturers will be able to build higher compression, fuel-saving engines and the oil men will be able to obtain a greater yield from a barrel of crude oil."

The question of customer acceptance was also brought out by two oil company engineers. Robert Greenshields, Shell Oil Co., said that it's already been shown how much fuel can be saved merely by inflating tires to say 50 lbs. "But how many motorists will do it? They won't, simply because of hard riding," he concluded.

Savings Are Small

The bother of using two fuels, or one and an anti-knock injection fluid, was also cited by Harold Gibson, research coordinator, Ethyl Corp. Mr. Gibson presented several charts showing results of extensive tests by Ethyl on both types of octane saving methods. He showed that the average user, driving 10,000 miles a year, would save only about $10.50 using the dual fuel system at the current price differential between regular and premium grade gasolines. "Even with a 5c differential, he would only save about $26 per year," Mr. Gibson stated.

He questioned the value of this saving when compared to the nuisance of maintaining required amounts of the two fuels in the tanks on the

car. For example, in some parts of the country, the motorist might conceivably do a great deal of mountain driving one day and city or flat country driving the next.

In general, road tests by Ethyl agree in results with those which were reported by all three engineers for both methods of saving fuel. In addition to passenger automobile tests, the company checked operation of the devices in intercity commercial tractor trailer fleets.

Additional evidence of satisfactory experience by an oil company using the Vita-Meter was described in a prepared discussion by Frank Burk, Atlantic Refining Co. Their results were based on tests with about 175 vehicles in the company's bulk hauling fleet. Trucks used the flange mounted model and a 50-50 water-isopropanol blend. Normal schedules were maintained during a 9-month period with no breakdowns due to the injection mechanism, Mr. Burk reported.

Atlantic showed an overall consumption rate of the fluid of 5.5% of the gasoline used on over 2 million miles of runs. Cost over the regular charge for gasoline was about 1c per gallon, with isopropanol costing about 40c per quart.

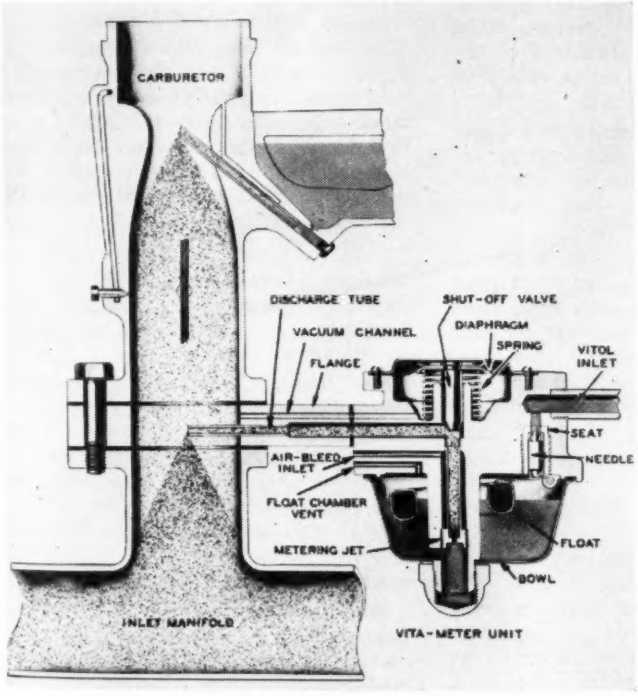
E. J. Bowhay, technical service division, The Texas Co., agreed with Mr. Holaday's original premise that high octane fuels are wasted to a great extent in today's cars. This company has found that from 85 to 90% of the new models are satisfied with regular gasoline. In a group of such cars on test runs, 64% showed loss of efficiency, or at least no benefit, by using premium instead of regular and then advancing the spark to help overcome knock. Bowhay recommended that serious consideration be given by engine manufacturers to the great possible advantageous effects of spark advance on detonation.

Dr. Lloyd Withrow, research division, General Motors Corp., said their tests have indicated that throttle opening also has an important effect on changes in road octane requirements of the newer high compression engines. GM has been doing extensive experimental work with a new car with an engine compression ratio of 10-1, Withrow reported.

Growing demands for high octane and high compression engines with decreasing prospects of satisfying the demands has put these power plants and fuels into the "luxury" class and may mean a greater stimulus for the use of Diesels, according to Arthur W. Pope, Jr., of Waukesha Motor Co.

Over 1000 SAE members attended the week long program, which included 17 sessions and 31 technical papers on all phases of automotive engineering.

How the Mechanical "Octane Savers" Operate



SCHEMATIC DIAGRAM OF DUAL FUEL CARBURETOR

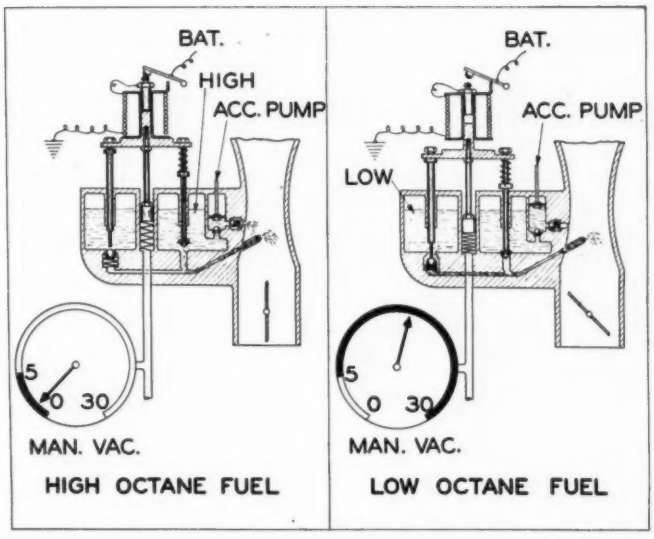


Fig. 2 (Above)—Socony-Vacuum's dual-fuel carburetor

Fig. 1 (Left)—The Thompson Vita-Meter

Fig. 1—Shows the recommended installation for the Vita-Meter in cars on the road today, a flange mounting between the carburetor and the intake manifold. The anti-knock "Vitol" is contained in a float bowl according to conventional carburetor practice. At closed throttle, high manifold vacuum keeps the spring-loaded, diaphragm valve closed, and no fluid flows. This is also true at part throttle. At full throttle opening, the spring overcomes the force exerted by the then low manifold vacuum, the valve opens, and the anti-detonant flows into the fuel line. The point at which this occurs is adjusted by means of the size of the interchangeable metering jet. For sharper control and improved blending with the air-fuel mixture on new cars, Thompson would install the device integral with the carburetor so that the fluid would be fed just at the throat of the carburetor venturi.

Fig. 2—Shows the Socony-Vacuum-developed dual-fuel carburetor. The bowl on the left contains low octane fuel: it supplies all the fuel for idle or part throttle operation until the manifold vacuum drops to the predetermined changeover setting. At that point, the step-up piston rises sufficiently to close a contact on a magnetic coil, closing the jet in the bowl on the left, and opening the jet in the bowl on the right. The bowl on the right contains the high octane fuel which is supplied when the manifold vacuum is below the changeover. All the fuel for the accelerating pump is also supplied from this bowl.

Design and Construction of

PRESSURE RELIEVING SYSTEMS

By NELS E. SYLVANDER and D. L. KATZ

Practical data on principles and methods for providing pressure relief for refinery equipment have been assembled through an API research project carried on at the University of Michigan. Present practices at refineries were surveyed.

A comparison is given of methods for predicting the rate of vapor generation in pressure vessels during fire exposure. Other causes of overpressure in refinery equipment are listed.

The accompanying is the first of two articles written for *PETROLEUM PROCESSING* by the two men who conducted the API research and who prepared the complete report on the project.(1)

THE need for pressure relief devices has long been recognized. Such devices have been employed for centuries. Mankind became aware of such needs when water was first heated to its boiling point and steam generated. Close fitting or weighted covers on ancient cauldrons or domestic pots probably resulted in occasional disaster, and man soon became aware of the need for loosely fitting lids and of the limitations of kettles under pressure.

The earliest safety valves were of the weight and lever type, the first reported being Papin's safety valve in 1695, which is identical with the modern weight-loaded valve in principle. Early use of pressure relief valves was to prevent explosions of stationary and marine boilers. Safety practices for sizing relief valves were established based on the burning grate surface.

Early in the development of power engineering, an overpressure of 10% beyond the set pressure of the relief valve was permitted to force the valve disc to a higher lift. A survey of the literature does not give an adequate reason for a 10% overpressure allowance, but it apparently was considered a conservative estimate based on vessel design. This practice has been followed for almost 100 years and today is accepted as an allowable standard.

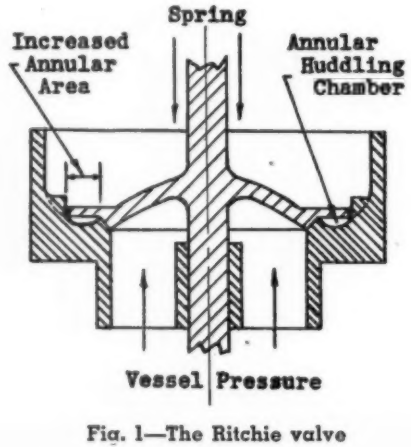


Fig. 1—The Ritchie valve

The difficulty in obtaining a high lift of the valve disc indicated at an early date the need for an improvement in design. The reaction-type safety valve resulted.

One of the first reaction-type valves was patented by Charles Ritchie in 1848. This safety valve had an annular lip extending all around the valve and an annular chamber for escaping steam. On opening, the steam gathered in the annular chamber, thus acting upon a greatly increased area, forcing the valve to a considerably higher lift. Upon closing, this valve closes slowly at first and then promptly.

An illustration of this early safety valve is presented as Fig. 1. This device was soon followed by numerous improvements along the same line. The "huddling chamber" became a standard for spring-loaded relief devices and permitted the design of relief valves to keep pace with the increasing pressures required in power engineering.

The design and adoption of inlet nozzles for improved reaction valves has resulted in relief valves which have orifice coefficients of 0.95 to 0.97 as determined by flow tests with steam.

The modern nozzle-type reaction relief valve, developed for the refining industry, is excellent from a mechanical and operating standpoint. It is a precision instrument and as such requires adequate inspection and servicing. The frequency for such work depends upon the service in which a valve is placed. Where relief valves are in corrosive service, or in service where deposits may build up tending to prevent their operation, such inspections should be quite frequent. On the other hand, in ideal clean conditions inspections may be necessary only as a guard against mechanical failings.

A pilot-operated relief device is finding increasing popularity for a pressure range of atmospheric to 150 psi at low temperatures. Rupture discs have received a limited acceptance and some auxiliary means of pressure relief are in use.

Determining Needed Relief Capacity

In some instances the cause of overpressure which results in the maximum relief capacity requirement is known. More frequently it is necessary to actually calculate the quantity of fluid relief needed for each of several causes. A check list for relief rate determination is presented in Fig. 2.

Allowable Pressure for Capacity Relief

The recommendations and formulas given in this section of the report(1) employ a maximum pressure within a vessel which can be permitted during the operation of pressure relief equipment. Relief devices should, therefore, be wide open at this pressure. This maximum is usually greater than the design pressure and will be defined before continuing with capacity determinations.

Some overpressure is required to assure full opening of most spring-loaded valves. The modern nozzle-type reaction valve, the most widely used today, is full open in vapor

THE AUTHORS

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TABLE 1.—Illustration of Pressure Terms a Propane Flash Tower as Used on a Solvent Dewaxing Unit

Item	Pressure Term	Back Pressure 0 p.s.i.g.	Back Pressure 30 p.s.i.g.	Factor of Safety
A.	**Design pressure**—Actual pressure used in stress calculations of equipment	280	280	4
B.	**Operating pressure**—Actual pressure under which equipment normally operates	250	250	4.5
C.	**Set pressure**—Actual pressure at which the relief device starts to open	280	280	4
D.	**Spring pressure**—Test bench setting of the relief valve spring to conform to operating conditions	280	250	..
E.	**Allowable pressure for capacity relief**—The set pressure plus a 10 per cent accumulation to assure a wide open relief valve for vapor flow	308	308	3.64
F.	**Initial hydrostatic test pressure on vessel**	420	420	2.67

service at 3% above its set pressure. The 10% allowance for pressure accumulation is apparently satisfactory as no known failures within this limit from strictly overpressure are known. Therefore, it is suggested that this be continued as the allowable pressure for vapor relief.

Relief valve manufacturers maintain that 25% pressure accumulation beyond the set pressure is needed to force the nozzle-type reaction relief valve to the full open position when in liquid service. It is suggested that 25% accumulation beyond the design pressure for wholly liquid or hydrostatic relief be used as the allowable pressure in the design. No added danger is thought to be involved from this increased pressure for liquid relief as the heat input from fire to liquid does not result in excessive metal temperatures.

To illustrate the relationship of overpressure beyond the set pressure to the rate of flow through nozzle-type reaction relief valves, a plot of the rate of flow vs. per cent pressure accumulation for water at 60° F. in lb./hr. and cu. ft./hr. through such a valve of 1.84 sq. in. orifice area is shown as Fig. 3. The valve is set to open at 200 psig. Similarly, the rate of flow in lb./hr. and cu. ft./hr. versus overpressure accumulation for saturated steam through the same valve is shown.

Reference to Fig. 3 shows that for vapor relief, the weight rate of flow increases for pressure accumulations in excess of 3% due only to the increasing density of the steam. The rate of liquid relief, either volumetrically or on a weight basis, increases for pressure accumulations in excess of 25% due only to the increased pressure drop available to overcome friction. The overpressure accumulation necessary to assure a wide open valve, 3% for vapor and 25% for liquid, is observed to be a function of the fluid flowing and not a fixed characteristic of the relief device. The illustration given is true for reaction-type relief valves but may not apply to other devices in which the lift of the disc off the seat is dependent on only a static pressure head.

To clarify the various pressure terms used, values for an actual processing vessel are tabulated in Table 1. In this table, a factor of safety based on the *API-ASME Code* is listed for each pressure condition.

The pressure listed for Item E, expressed as absolute pressure would be used in calculating the area required for flow.

Determination of Maximum Rate of Fluid Relief for Governing Condition

The governing condition is that cause which requires the maximum pressure relief and accordingly is used in calculating the relief area to be supplied. Each cause will be treated as if it were a potential governing condition. A flow sheet of a typical refinery operation is presented as Fig. 4 and will be referred to in the following discussions.

1. Failure of the Cooling Water Suppy: To illustrate the over-pres-

Vessel or System_____
Design Pressure_____
Set Pressure of Relief Device_____
Allowable Pressure for Capacity Relief_____
Operating Conditions: Fluid_____ Mol. Wt._____ Sp. Gr._____ Temp._____ Latent Heat_____ Corrosive_____
Physical Conditions: Vessel Dimensions_____ Insulation_____ Fire Control Measures_____

	Cause of Overpressure	Capacity Requirement (lb./hr.)
1.	Failure of Cooling Water	
2.	Reflux Failure	
3.	Entrance of a More Highly Volatile Fuel	
4.	Vapor Generation from Fire Exposure	
5.	Excessive Operation Heat Inputs	
6.	Accumulation of Non-condensibles	
7.	Closed Outlets	
8.	Failure of Automatic Controls	
9.	Internal Explosions	
10.	Chemical Reaction	

Causes which may occur simultaneously_____
Probability of occurrence_____
Allowance to be made_____

Relief Capacity Used for Selecting Valves

	Auxiliaries	Cause of Overpressure	Capacity Requirement (lb./hr.)
1.	Exchangers	Split tube or tubes Thermal vaporization	
2.	Pumps	Discharge restriction	
3.	Lengths of Line	Thermal vaporization	

Relief Area Calculation

	Equipment	Capacity lb./hr.	Relief Area, sq. in.
1.			
2.			
3.			

Fig. 2—Check list for the determination of the rate of vapor relief

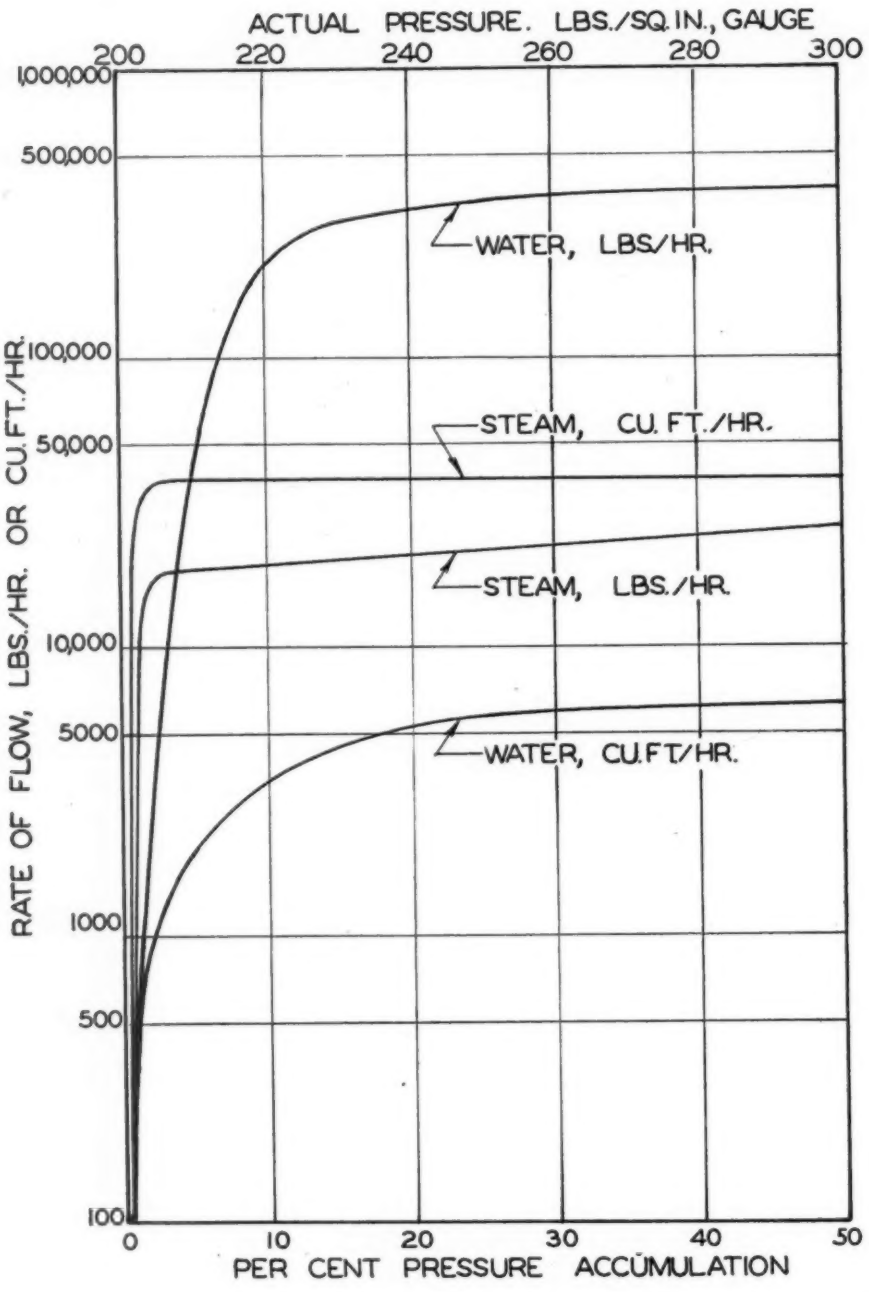


Fig. 3—Rate of flow with varying pressure accumulation for steam and water through a nozzle-type reaction relief valve. 1.84 sq. in. nozzle area. 200 lb./sq. in. set pressure

sure requirements for this case, reference should be made to Fig. 4. Towers 12 and 39 in this figure would be overpressured if the water to condensers 18 and 33 were lost. Tower 12 would require capacity relief through valves 10 and 11 of a combined total equal to the overhead stream flowing through the condenser 18. Tower 39 would not necessarily require relief capacity equal to the overhead stream through valves 37 and 38, as the back-pressure control valve 32 would assist in maintaining pressure. However, valve 32 is not an emergency relief device and should be discounted in capacity calculations for pressure relief if it can become closed for any reason during an overpressure period.

2. Reflux Failure: This is a frequent cause of overpressure but need not cause an excessive pressure rise. If heat removal in the overhead condenser is limited, and uncondensed vapor cannot be removed from the overhead accumulator, a reflux failure could result in a vapor-bound condenser.

Reflux failure on towers 12 and 39 in Fig. 4 could not require relief capacity greater than required for Item 1. It is possible that under some operating conditions where the overhead stream is not condensed, reflux failure may be a major item for consideration.

3. Entrance of a More Highly Volatile Fluid: This condition can cause immediate and greatly excessive pressure if an appreciable quantity of fluid is permitted to enter equipment operating at a temperature well in excess of the fluid's boiling point.

In Fig. 4 a considerable quantity of propane could enter into the feed stream to tower 12. A propane-rich vapor would accumulate immediately in reflux drum 21 and the pressure rise resulting could block the flow of vapor through condenser 18. Should the propane continue to enter with the feed stream, relief valves 10, 11 and 20 would be required to release the normal overhead rate through condenser 18 plus the additional propane vapor entering.

Tower 39 could conceivably receive butane due to misoperation of tower 12. The presence of butane in the feed to tower 39 would not necessarily cause excessive overpressure, as the backpressure control valve 32 is purposely supplied to remove such non-condensibles. If backpressure control valve 32 is small, relief valves 37 and 38 must then be sufficient to remove the total overhead plus the quantity of butane which cannot be removed through valve 32. Additional relief could be secured from relief valve 41 if it is supplied for tower protection as well as reboiler protection.

4. Vapor Generation Due to Fire Exposure: The rate of vapor generation within a vessel exposed to fire cannot readily be determined. Many factors influence this rate and possibly the greatest variable factor is the extent and duration of the fire.

Until the characteristics of uncontrolled open fire and of vapor generation rates within exposed vessels are better understood, positive recommendations for relief capacity cannot be made. Indications of rapid pressure rise from actual fire records tend to show that heat transfer by radiation and surface boiling are greater influencing factors in the initial relief capacity calculations than the size of the vessels or the volume of stored material. The survey of the refining industry showed that many methods of determining relief capacity requirements for fire exposure are in use.

Method A: PAW Wartime Recommendation

This recommendation can best be presented in graphical form and is shown as Fig. 5. It is suggested that,

where this chart is to be used for determining heat input, the exposed surface area be determined as given below: The exposed surface area for horizontal drums less than 20 ft. in diameter is to be one-half of the cylindrical surface and all of the surface of both heads; for horizontal drums greater than 20 ft. in diameter, all of the area up to 20 ft. above grade—a level where hydrocarbon can accumulate.

The exposed surface area for vertical drums, less than 20 ft. in height, is to be the sum of the circumferential and lower head surfaces; for a vertical drum greater than 20 ft. in height, the lower 20 ft. of circumferential surface plus the surface of the bottom head. For insulated vessels having a well-bound and hard-surfaced insulation, approximately 2 in. thick, the heat input may be figured as 20% of that to an uninsulated vessel.

Method B: Heat Input Rates of 20,000 or More Btu/hr./sq. ft.

Relief capacities are calculated from formulas similar to the following:

$$[(Q/A) \times A]/L \quad \text{..... 1}$$

(for an uninsulated vessel)

In the above formula:

W = vapor discharged, lb./hr.

Q/A = the heat flux in Btu./hr./sq. ft., generally 20,000 to 22,000 Btu./hr./sq. ft.

A = surface of vessel exposed to fire, sq. ft.

L = latent heat at allowable pressure for capacity relief, Btu./lb.

Some companies scale down the area considered as exposed, depending on the diameter and overall length of the vessel. Others use the internally wetted surface only in computing heat transferred to the vessel contents.

Method C: The Stroop-Maker Formula

This formula may be written either as

$$Q/A = 48{,}000/(A)^{1/3} \quad \text{..... 2}$$

(in Btu./hr./sq. ft.)

$$Q = 48{,}000\ (A)^{2/3} \text{ in Btu./hr.} \quad \text{.. 2a}$$

In these equations, (A) is specified as the area of wetted internal surface.

Method D: The Fetterly Equation

This equation for determining the heat input *rate* to an uninsulated vessel during fire exposure is:

$$U = (1200^\circ \text{ F} - T)/(62.5 + 20t) \quad 3$$

In this equation:

U = Btu./hr./sq. ft./° F

T = temperature of contents at maximum relieving pressure, ° F

t = thickness of container wall, inches

Method E: State of California, Dept. of Industrial Relations

This method is intended for the liquefied petroleum gas industry for relatively small vessels but has been used in the design of refineries. The recommended equation is:

$$a = 0.77A/P \quad \text{..... 4}$$

In this equation:

a = required relief area, sq. in.

A = total surface area, sq. ft.

P = design pressure, psia

Method F: Handbook Butane-Propane Gases

This method recommends relief capacity equivalent to a vapor generation rate of 100 lbs./hr./sq. ft. of exposed surface.

Method G: Allowance for Water Application

This method is based on the effec-

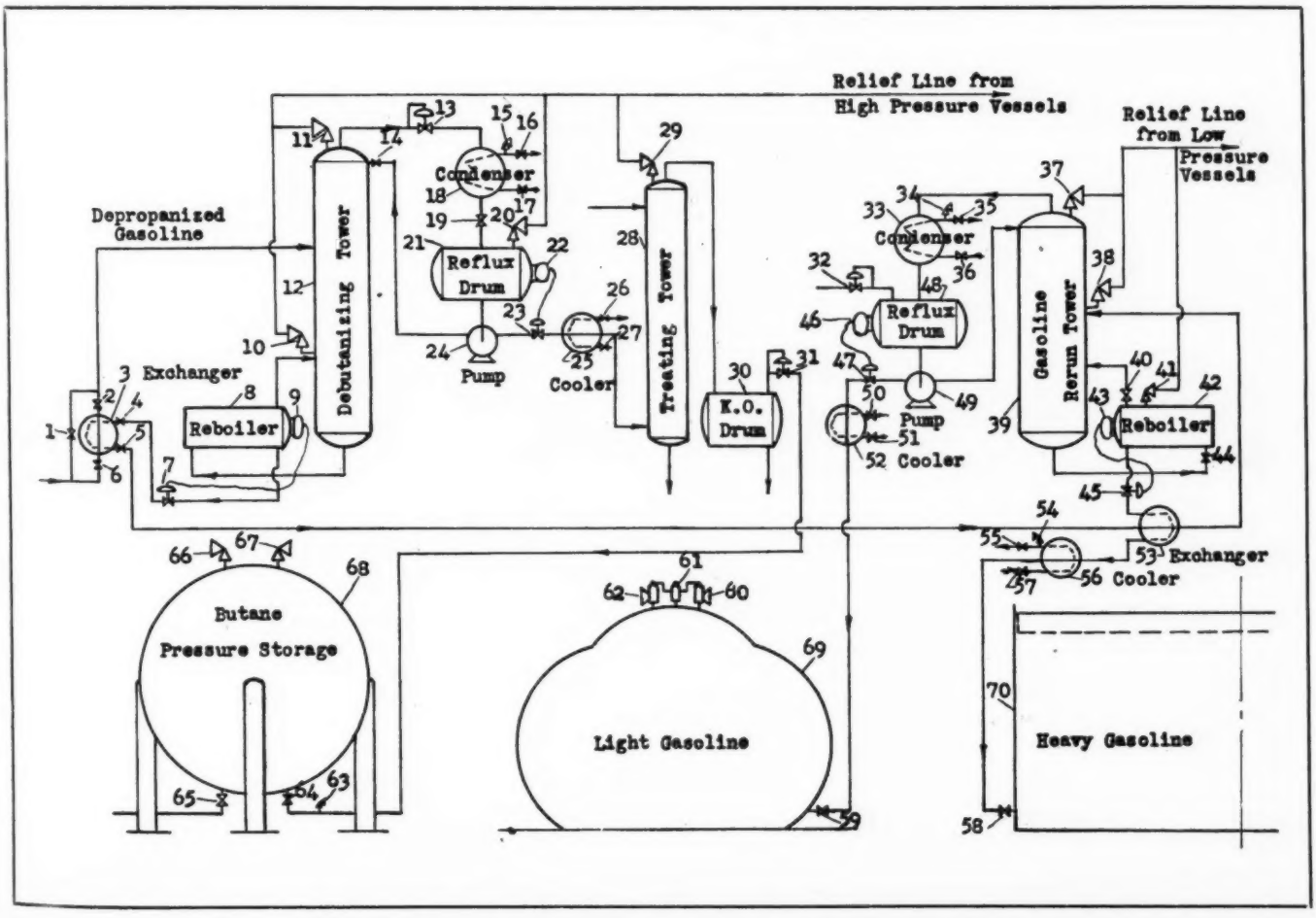
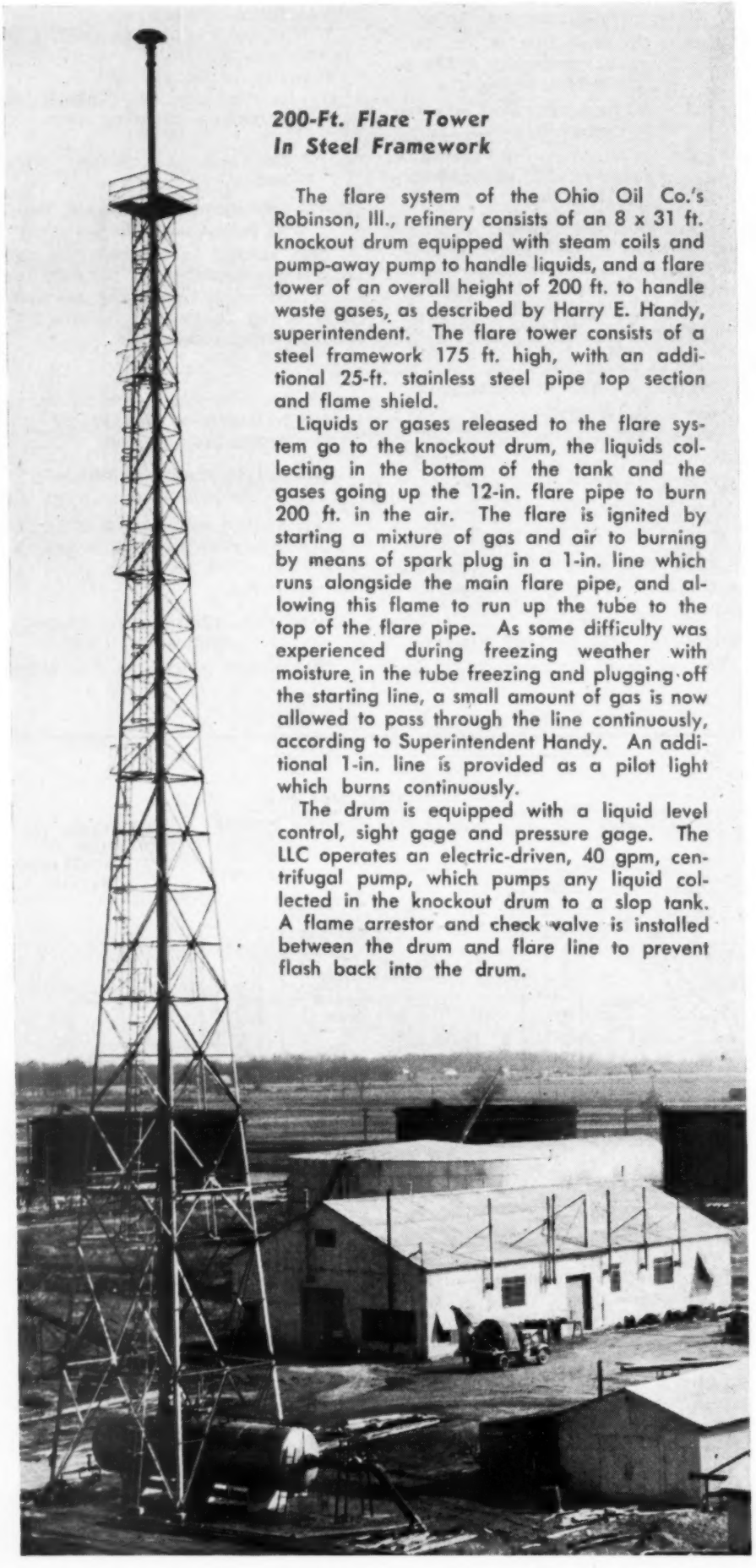


Fig. 4—Flow sheet of typical refinery equipment requiring overpressure protection



200-Ft. Flare Tower In Steel Framework

The flare system of the Ohio Oil Co.'s Robinson, Ill., refinery consists of an 8 x 31 ft. knockout drum equipped with steam coils and pump-away pump to handle liquids, and a flare tower of an overall height of 200 ft. to handle waste gases, as described by Harry E. Handy, superintendent. The flare tower consists of a steel framework 175 ft. high, with an additional 25-ft. stainless steel pipe top section and flame shield.

Liquids or gases released to the flare system go to the knockout drum, the liquids collecting in the bottom of the tank and the gases going up the 12-in. flare pipe to burn 200 ft. in the air. The flare is ignited by starting a mixture of gas and air to burning by means of spark plug in a 1-in. line which runs alongside the main flare pipe, and allowing this flame to run up the tube to the top of the flare pipe. As some difficulty was experienced during freezing weather with moisture in the tube freezing and plugging off the starting line, a small amount of gas is now allowed to pass through the line continuously, according to Superintendent Handy. An additional 1-in. line is provided as a pilot light which burns continuously.

The drum is equipped with a liquid level control, sight gage and pressure gage. The LLC operates an electric-driven, 40 gpm, centrifugal pump, which pumps any liquid collected in the knockout drum to a slop tank. A flame arrestor and check valve is installed between the drum and flare line to prevent flash back into the drum.

tiveness of water application from fixed systems to vessels during fire exposure in reducing heat input. The expected coverage with water permits scaling down experimental heat input values from the Rubber Reserve Tests at Baytown to approximately 1.5 times the P.A.W. recommended heat input curve.

The heat input values calculated for the example vessel in each method are tabulated in Table 2.

5. Excessive Heat Inputs Other Than From Fire: Vapor generation from operating heat inputs can become the governing factor in pressure relief requirements where vessels are adequately insulated against heat input from fire.

A possible example of overpressure from an excessive operating heat input could occur in a flash tower with the feed stream coming from a fired coil furnace. Assuming that the flash tower vapor line normally operated at its flow capacity, pressure rise would be rapid if the feed stream were heated to an excessively high temperature in the furnace, which could occur if gasoline drips entered the fuel gas line to the furnace. This pressure rise could come from vapor generation of heavier materials or from additional cracking in the furnace coil. In this example, the additional vapors due to cracking might be difficult to estimate.

6. Accumulation of Non-condensible Gases: This cause of overpressure can be considered as a special case under item 3, "Entrance of a More Highly Volatile Fluid". A separate listing is made to call attention to a possible long-time accumulation of inert gases which may eventually block flow through condensing or cooling equipment.

7. Closed Outlets: Occasionally, the outlet lines from operating vessels are inadvertently blocked off, either through misoperation of flow control valves or stop valves, by a build-up of solid materials, or even by failure to remove blinds prior to a start-up. If a vessel is operating liquid full when this occurs, the pressure rise is immediate. Pressure relief is then essential if the charge source to the vessel is at a higher pressure than the allowable working pressure of the vessel in question.

The treating tower 28 and treating fluid knock-out drum 30 as shown in Fig. 4 would require liquid relief through relief valve 29 if either pressure control valve 31 or block valve 64 should become closed. This assumes the discharge pressure of pump 24 through cooler 25 to be in excess of the set pressure of relief valve 29.

Special attention should be given

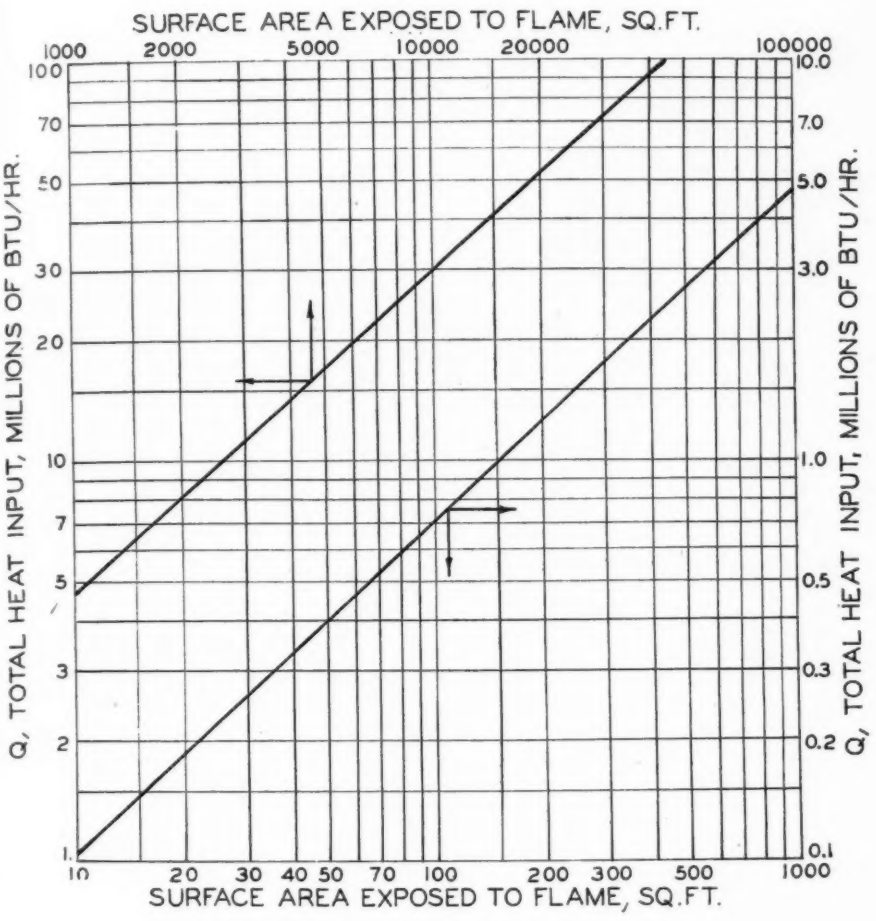


Fig. 5—P.A.W. recommended heat input curve

to systems where a closed outlet will permit liquid to accumulate in a receiving vessel until condensing units are flooded. The relief capacity required for the resulting pressure rise should not be greater than that needed for the loss of cooling medium, but a relief device on the vessel which fills completely will release liquid if its set pressure is at or below that of relief devices on vapor spaces in the system. The release of liquid may or may not be desirable.

Again referring to Fig. 4, a closed level control valve 23 could cause the reflux drum 21 to fill completely and soon flood the condenser 18. Flooding of condenser 18 would cause excessive pressure on tower 12 and drum 21. During such an overpressure period, relief valve 20 would discharge liquid if it operated, while relief valves 10 and 11 would discharge vapor. If the total relief area of valves 20, 11 and 10 were needed to care for loss of the condenser heat removal, operation of relief valve 20 would mean that valves 11 and 10 would have a lighter duty due to the condensation of that liquid leaving through valve 20.

Pumps and compressors may also require overpressure protection from this cause.

8. Overfilling a Pressure Storage Vessel: It is believed that this possibility of overpressure in pressure storage vessels is not fully appreciated. This is particularly true where high capacity pumps are used in transferring stored products from one vessel to another or where the filling stream is from equipment operating at a much higher pressure through a flow control valve. It is advised that liquid relief capacity be provided on pressure storage vessels equal to the possible run-down rate from the process unit at the relieving pressure. This would mean that no additional relief capacity would be necessary if the discharge pressure of a transfer pump were less than the relieving pressure of a relief device. However, if a transfer pump can discharge at a higher pressure, sufficient additional relief capacity should be added to care for the possible flow at relieving pressure during fluid transfer.

9. Failure of Automatic Flow, Temperature or Pressure Control Valves: The incidents listed as Items 1, 2, 3, 5 and 7 could all occur as a result of control failures.

An example of the failure of a flow control valve can be cited in Fig. 4. If level control valve 7 should fail in the open position, the liquid level in reboiler 8 could rapidly be lost and a vapor blow-through could occur from tower 12 to tower 39. If this occurred, relief valves 38 and 37, possibly assisted by relief valve 41 and backpressure control valve 32, would be required to release a large quantity of light vapor.

Other causes of overpressure are internal explosions, chemical reaction, split exchanger tubes and thermal expansion of liquids.

In a continuous refining system it is entirely possible that some of these recommendations will require a maximum relief capacity for only a short time interval, followed by decreasing needs as the flow from one vessel to another is decreased. This possibility should not be a justification in decreasing relief capacity on individual equipment but should be considered in the design of relief discharge disposal systems.

References

(1) "Design and Construction of Pressure Relieving Systems", Engineering Research Institute Bulletin No. 31, University of Michigan Press, 311 Maynard St., Ann Arbor, Mich. Available at $3 per copy.

TABLE 2.—A Comparison of the Heat Input Values (Q) for the Example Used in Methods A to G

Example Vessel: Reflux Drum 21 in Fig. 3

Vessel Specifications

Dimension—8 ft. x 12 ft.
Shell thickness —0.5 in.
Design Pressure—75 psig
Relief valve set pressure—75 psig
Allowable pressure for capacity relief—97.2 psia
Total surface area—402 sq. ft.
Uninsulated

Operating Conditions

Fluid in vessel—n-Butane
Latent heat—137 Btu/lb. at 97.2 psia
Saturated temperature—143° F at 97.2 psia
Normal liquid level—½ full
Wetted shell area—251 sq. ft.

Method	Heat Input Formula	Surface Area Sq. Ft.	Total Heat Input, Btu./hr.
A. P.A.W.	Fig. 4	251	1,500,000
B. 20-22,000 Btu./hr./sq. ft.	Eq. 1	385	8,470,000
		251	5,020,000
C. Stroop-Maker	Eq. 2a	251	1,910,000
		402	3,600,000
D. Fetterly	Eq. 3	402	6,260,000
E. State of Calif.	Eq. 4	402	5,060,000
F. Handbook Butane-Propane Gases	See pg. 14	402	5,500,000
G. 1.5 P.A.W.	See pg. 14	251	2,250,000 With Water Spray

View of Oceco 3" Screwed Connection Vent Valve with Flame Snuffer and Chain.

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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Can mechanical efficiency be increased in a gas engine-driven compressor by using a low viscosity lubricating oil?

It is true that high-speed or automotive type engines do have a higher mechanical efficiency with light oils. The point is that the fluid friction of a high viscosity oil will cause a high-speed engine to have a lower mechanical efficiency, resulting in high fuel consumption. However, with the large bore slow-speed engines, fluid friction ceases to be the predominant factor in determining mechanical efficiency.

Several years ago we ran a mechanical efficiency test on a 5½" x 7" engine operating at 1500 rpm. The mechanical efficiency was 12% higher when SAE 10 oil was used than with SAE 40. More recently the mechanical efficiency at 1000 rpm. was determined on an 8¾" x 10½" engine. We could find no appreciable difference in efficiency when the oil was changed from SAE 40 to SAE 10. On an 18" x 20" engine at 250 rpm. we obtained 4% better mechanical efficiency when we changed from SAE 30 to SAE 50 oil.

Often the heavier oils will give much better cylinder and ring life and will result in a material saving in oil consumption. A smaller quantity of the heavier oil will give better lubrication than flooding the cylinders with a light oil. The carbon formation will be less when the correct quantity of the heavier oil is used.

Frequently SAE 20 or 30 oil is used when a smaller quantity of SAE 40 or 50 oil would give better lubrication and substantial saving in oil cost. Scuffing in compressor cylinders or excessive ring wear often can be overcome by the use of heavy oil. In extreme cases we have used oils as heavy as SAE 90 with very good results—unless the presence of oil in the gas being compressed is objectionable, in which case a lighter oil must be used.

What is the future of ethane in the chemical field, as it pertains to the natural gasoline plant operator?

The biggest question or biggest factor in the question would be: "What can the natural gasoline manufacturer do to furnish the ethane or recover it so that it can be utilized?" The problems are old due to the fact that ethane cannot be stored in the same sense as can propane or higher hydrocarbons. In attempting to increase the recovery of ethane in order to retain sufficient value to make its recovery worthwhile, large amounts of methane are recovered, which makes the purification of the ethane quite a problem. The incentive for the augmented recovery and the expensive purification of ethane is lacking, since at the present time there is no stable or common value for ethane.

Since ethane cannot be transported, the consumer of ethane has as his only recourse the placing of his chemical plants adjacent to the gasoline plants producing the ethane. In most instances there would not be enough ethane recovered in any one location to make this feasible. Ethane is the last of the hydrocarbons, outside of methane, that might be called a "low value product." It probably will stay of low value as long as it cannot be transported and stored.

There are instances now where ethane is being utilized at natural gasoline plant sites, but these consumers are all at exceptionally large plant installations, and the material is being transported in combination or admixture with propane and butane or similar materials to reduce vapor pressure. The answer to the problem really revolves around a solution of the ethane handling problem.

There are several known instances of ethane being used in connection with propane for the production of ethylene. There are probably others where it is separated at the point of manufacture and utilized separately—and usually for conversion into ethylene. At the present time, so far as it is known, it is not being used for any synthesis that is not equally applicable to propane—which does not mean that it would not be in the future.

Ethane as a chemical starting point has greater possibilities than propane and due to a non-competitive LPG factor, it is due for more immediate attention by propane-to-chemicals consumers.—J. E. Bludworth, Petroleum and Chemical Consultant, Corpus Christi. Texas.

Data in answer to questions presented on these pages is supplied through the cooperation of authorities with the equipment and engineering companies of the Natural Gasoline Supply Mens Assn., among others. Readers are invited to submit queries on plant operating problems in their own work.

What determines the maximum pressure for which a centrifugal compressor can be built?

There are two prime considerations involved: first, the availability of a driver; second, the economic feasibility of a centrifugal compressor as compared to other types available.

From the standpoint of the driver, there are available today both direct connected steam turbines and motor-gear combinations capable of developing sizable horsepowers at speeds up to 10,000 rpm. High pressure centrifugal compressors will in general require relatively high rotative speeds. The actual selection of the driver must be determined by the availability of power and the relative cost of steam versus electrical energy.

From the standpoint of economic feasibility, there are several important considerations:

A centrifugal compressor is fundamentally a large capacity machine as compared to a reciprocator. The importance of capacity increases as the compression ratio increases. For capacities of 10,000 cfm. and upwards, a centrifugal machine generally will show up more favorably from the standpoint of first cost than it will for smaller capacities.

The efficiency of a reciprocating machine is generally somewhat higher, but the maintenance on a centrifugal machine is usually in its favor and sometimes more than balances the better efficiency of a reciprocating compressor.

Where oil-free compression is a requisite, such as the handling of oxygen, a centrifugal machine is necessary regardless of the economics. (Relatively small capacities in reciprocators have been built without internal oil lubrication.)

In the handling of gas appreciably lighter than air, a centrifugal machine is handicapped in comparison with a reciprocator, since additional stages are required by reason of the

lower inlet density. To determine the economic feasibility of a centrifugal compressor for any specific application, it is necessary to analyze carefully all of the operating conditions. —R. N. Williams, Blower Dept., Elliott Co., Jeannette, Pa.

To what extent should natural gasoline plant equipment be "grounded"? Should all types of equipment be grounded and is a "network" system necessary? Will grounding reduce insurance rates?

The question would be more accurately stated if the word "bonding" was substituted for "grounding," as the latter is less technically correct although commonly used. You don't ground the equipment in the sense that a wire or other conductor is run from the individual piece of equipment to a rod buried in the ground.

Instead, each piece of equipment is connected to other items by metallic means—welding, jumpers around "insulated" type flanges, and other types of connection. Piping from this equipment entering the ground then provides a final safe path to conduct any static electricity to earth. No static flashes will occur in properly bonded equipment.

Static electricity is yet a great mystery and it is doubted if electronicists and other energy specialists know all there is to know about it. Static electricity often is regarded as a "cold" spark, incapable of igniting an explosive mixture. There are, however, indisputable cases on record where it was not regarded as possible that other means of ignition were present. Static sparks may not ignite a combustible mixture every time, but eventually they will. G. M. Kintz, U. S. Bureau of Mines, Dallas, has a very striking laboratory demonstration of static sparks igniting an explosive mixture. This has been given before large groups in many parts of the country and during the last International Petroleum Exposition.

Presumably by "network" the questioner means connecting the various items of equipment in series. There is no objection to that, providing a good bond is achieved and any charges which may be generated are eventually conducted to earth. Any equipment in a location where inflammable vapors are likely to be present at any time should be bonded. Static electricity is likely to be present whenever friction or motion between two dis-similar substances is possible or where a non-conducting liquid is present—especially if the liquid is moving.

Atmospheric conditions also seem to have a lot to do with generation of static charges; dry, cold conditions being especially favorable. It is often present in most West Texas and New Mexico areas, and to a considerable extent in Oklahoma and other parts of Texas except in the damp, humid Coastal areas.

"Bonding" will not necessarily lower insurance rates in and of itself. Insurance rates are based on experience. Where bonding is not practiced, the experience will be less satisfactory, with resultant increased costs and greater insurance premiums. A program of proper bonding will minimize flashes and explosions, reduce costs and thus reflect a better experience. The better experience will be credited in insurance rates.—Henry W. Boggess, Superintendent of Safety, Sinclair-Prairie Oil Co., Tulsa.

What are the advantages and disadvantages of induced vs. forced-draft air circulation in cooling towers or air-cooled exchangers?

Induced draft means that the tower or exchanger is on the suction side of the fan; forced draft is the reverse arrangement.

There are two principal advantages in using induced rather than forced draft:

1. Distribution of air through the coil of the exchanger or the tower cell is very uniform, thereby giving maximum cooling efficiency. With forced draft there is likely to be a "dead area" surrounding the center of the fan.

2. Induced draft permits low air velocities through the coil or tower, giving high thermal efficiency in heat removal with low fan horsepower demand. At the same time the exit may be restricted to produce air velocities high enough to get the heated air away from the unit. This minimizes possibility of recycling used air through the unit.

A third, but relatively minor, advantage is that in cold weather conditions may be favorable to ice formation on the fan in a forced draft system, damaging blades or bearings. This cannot happen with an induced draft system because the fan handles only warm air.

The principal disadvantage of induced draft is that, for a given installation, it will require greater fan horsepower than a forced draft system. The reason is slightly involved.

The amount of air required to do a given cooling job under any assumed conditions must be calculated in pounds; fan capacity is determined in cubic feet, whereby the density of the air becomes an important factor. The air handled with an induced draft fan will be at least 30 to 40° higher in temperature, and correspondingly less dense, than that handled by the forced draft fan. Since the fan in a forced draft system handles cool air, the volume required for the desired number of pounds of air will be less than for the fan on an induced draft system, thereby requiring less horsepower.

This advantage in power requirement is not as apparent in practice as it is in theory, because the air moving through the coils of the induced draft system has less turbulence than with the forced draft system. With the forced draft fan, the increased turbulence will require more horsepower to overcome it.

In small installations the question of forced vs. induced draft becomes one of the designer's preference rather than horsepower, since the actual power requirement differential becomes vanishingly small. In larger units it should be regarded as a matter of economics and engineering judgement.—O. L. Smith, The Happy Co., Tulsa.

What are the necessary tests and their purpose in maintaining adequate control of boiler water?

There are a great number of tests required or which may be desirable in maintaining proper control of boiler water treatment, depending on the type of treatment or information sought. Ordinarily they may be boiled down to 3, or perhaps 5, common tests. Alkalinity (methyl orange and phenolphthalein), chloride and hardness tests are always required. Oftentimes such supplementary tests as phosphate and sulfite may be required.

Alkalinity is used to control the amount of softening reagent used. The chloride determination is used to fix the continuous blowdown rate in avoiding excessive accumulation of solids, or to regulate the amount a boiler or cooling water system should be blown down. A phosphate test is necessary when soda and phosphate are fed separately.

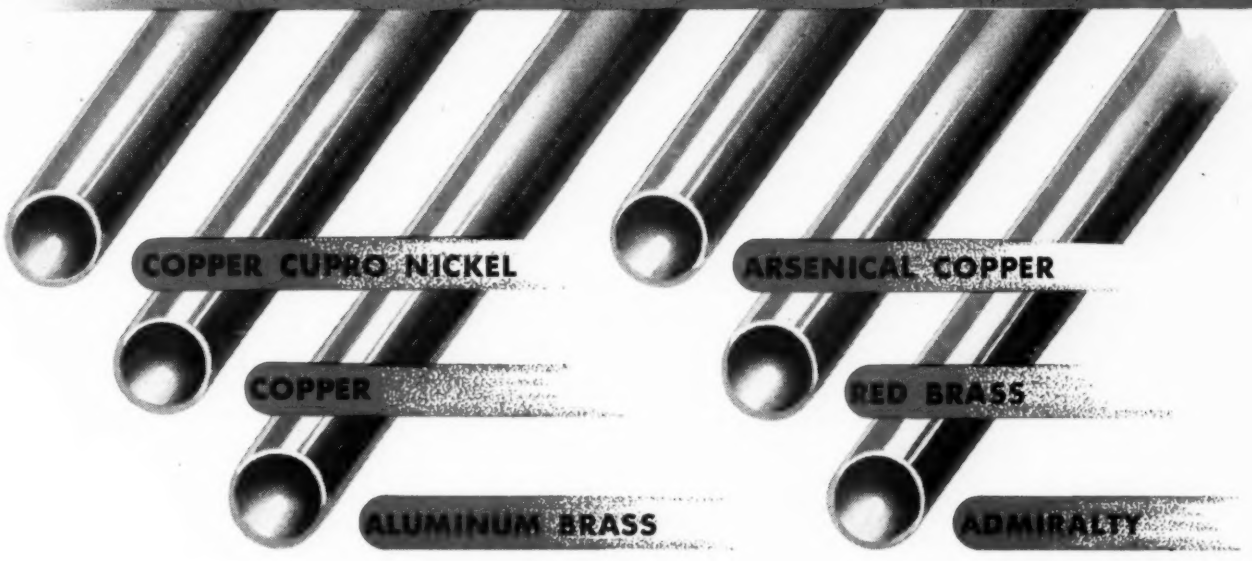
The hardness test is used to determine if treatment is actually effective and water is "soft."

Sulfite concentration is required in the event an oxygen-absorbing treatment is being used, to determine its effectiveness.

One of two other tests may be necessary when there is a possibility of caustic embrittlement, sulfate or nitrate concentrations. The sulfate test is used when it is necessary to maintain an adequate sulfate-to-alkali ratio in the prevention of caustic embrittlement. Likewise, a nitrate determination is used when sodium nitrate is added for the control of caustic embrittlement tendencies.

All of these tests are relatively simple and require neither complicated and expensive apparatus nor a technically-trained operator.—R. W. Kelly, Dearborn Chemical Co., Tulsa.

Wolverine Makes Condenser Tubes IN MANY ALLOYS besides Admiralty



You are invited to consult our Customer Engineering Department in selecting tube of the proper alloys that will meet the particular conditions under which you work.

Much loss, due to corrosion, can be eliminated by making sure that the condenser tubes used in your heat exchange equipment are made of the proper alloys.

There are many types and forms of corrosion that result in ultimate failure. It is only through long experience with a wide variety of conditions, together with a thorough knowledge of the chemical reactions of metals to various elements, that enable one to take preventive steps to guard against the losses suffered through corrosion.

We offer you the benefit of this experience and knowledge, and invite your consideration of Wolverine non-ferrous seamless tube and our specialized services.

Send for our Brochure K-7 that gives helpful information about condenser tubes.

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CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
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MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
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New "PRECISION" 5-UNIT GUM IN GASOLINE APPARATUS

AIR JET METHOD

USING ALUMINUM BLOCK BATH

A. S. T. M. - D-381

Developed to eliminate the difficulties encountered when using an Ethylene Glycol Bath for Gum Determinations, the "Precision" Gum in Gasoline unit shown above represents a major improvement over existing equipment. Tests show that air flow and temperature uniformity are well within A.S.T.M. requirements.

FEATURES

The aluminum block contains five equally spaced holes 2-1/16" diameter, 2-3/4" deep, accommodating five 100 cc lipless Berzelius type beakers. Center of the block forms integral air distribution chamber to insure uniformity to all five air nozzles. A long continuous air pre-heating spiral is cast inside block and stainless steel sheathed electric heating units are clamped to the block bottom. Temperature is easily maintained at normal operating levels well within A.S.T.M. requirements. Temperature of block which determines temperature of beakers and air jets is automatically controlled by adjustable hydraulic thermostat. Heavy glass wool insulation between block and outer sheet metal casing reduces heat loss to absolute minimum. Neon pilot light indicates thermostat operation, and line switch and auxiliary switches control the heating elements. Dial type air flow gauge eliminates need for orifices or capillaries.

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Scientific Research and Production Control Equipment

Inverted Glass Carboys on a Table Make Useful Laboratory Tanks

A USEFUL laboratory utility tank with a cone bottom can be made by cutting a 4-in. diameter hole in the bottom of ordinary 5 or 10-gal. glass carboys—such as are used for shipping acid.

Properly mounted and equipped, these tanks can be used for water or acid washing, settling, airblowing, and many other processes encountered in a petroleum laboratory. Being made of glass, there is little danger of catalytic effect or chemical contamination, and the technician can readily observe the operation. Because the glass is of the "common" type, however, exposure to thermal shock is not recommended, and mechanical strains must be avoided.

As used in the laboratories of Humble Oil & Refining Co. at Baytown, Texas, refinery, the tanks are mounted in pairs on a sturdily built rolling table. The top of the table in Fig. 1 has a beveled, circular opening to take the neck of each carboy. It is large enough—6-in. diameter—to afford considerable support and rigidity to the inverted carboy.

An ordinary rubber stopper carrying a convenient length of ½-in. iron nipple and a globe valve is inserted in the mouth of the carboy to complete the assembly. A wooden board at the proper level beneath the table top provides the support necessary to prevent the stopper from dropping out of the mouth of the bottle. (See Fig. 2).

The entire valve assembly may be readily dismounted for cleaning if desired, and any needed "plumbing" may be connected through the stopper or to the globe valve. The ease of portability of the unit is an added advantage.

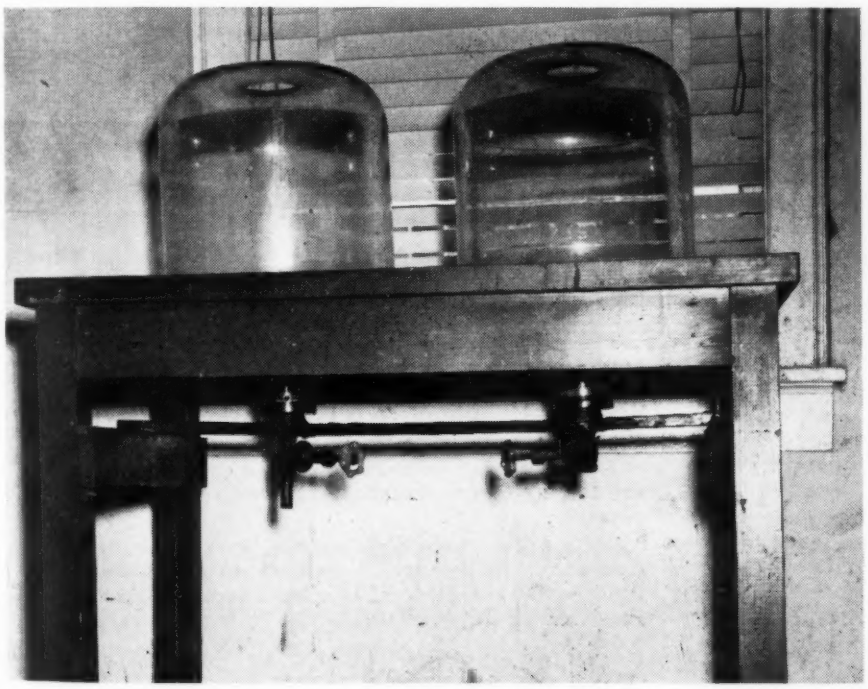


Fig. 1—Utility tanks for large scale laboratory operations made from old 10-gal. acid carboys mounted on a sturdy table

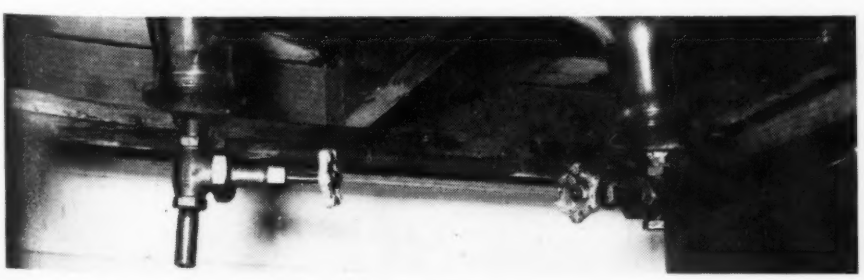
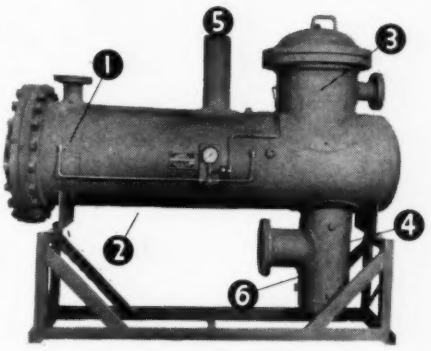


Fig. 2—Wooden support underneath table prevents corks from dropping out; also braces bottles when table is moved

10 GPM TO 1500 GPM

EXCEL-SO FE



Here are the working stages of the FE:

1. 1st Stage—Pipe Scale, etc.
2. 2nd Stage—25 Microns or Larger
3. 3rd Stage—10 Microns or Smaller
4. Water Accumulator Chamber
5. Air Eliminator Mechanism
6. Steam or Electrical Immersion Heaters, if desired.

The combination Water Separator and 3-Stage 10-Micron Filter handles the job in ONE installation.

WARNER LEWIS COMPANY
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USE THIS COUPON

Please send complete information on your "FE"

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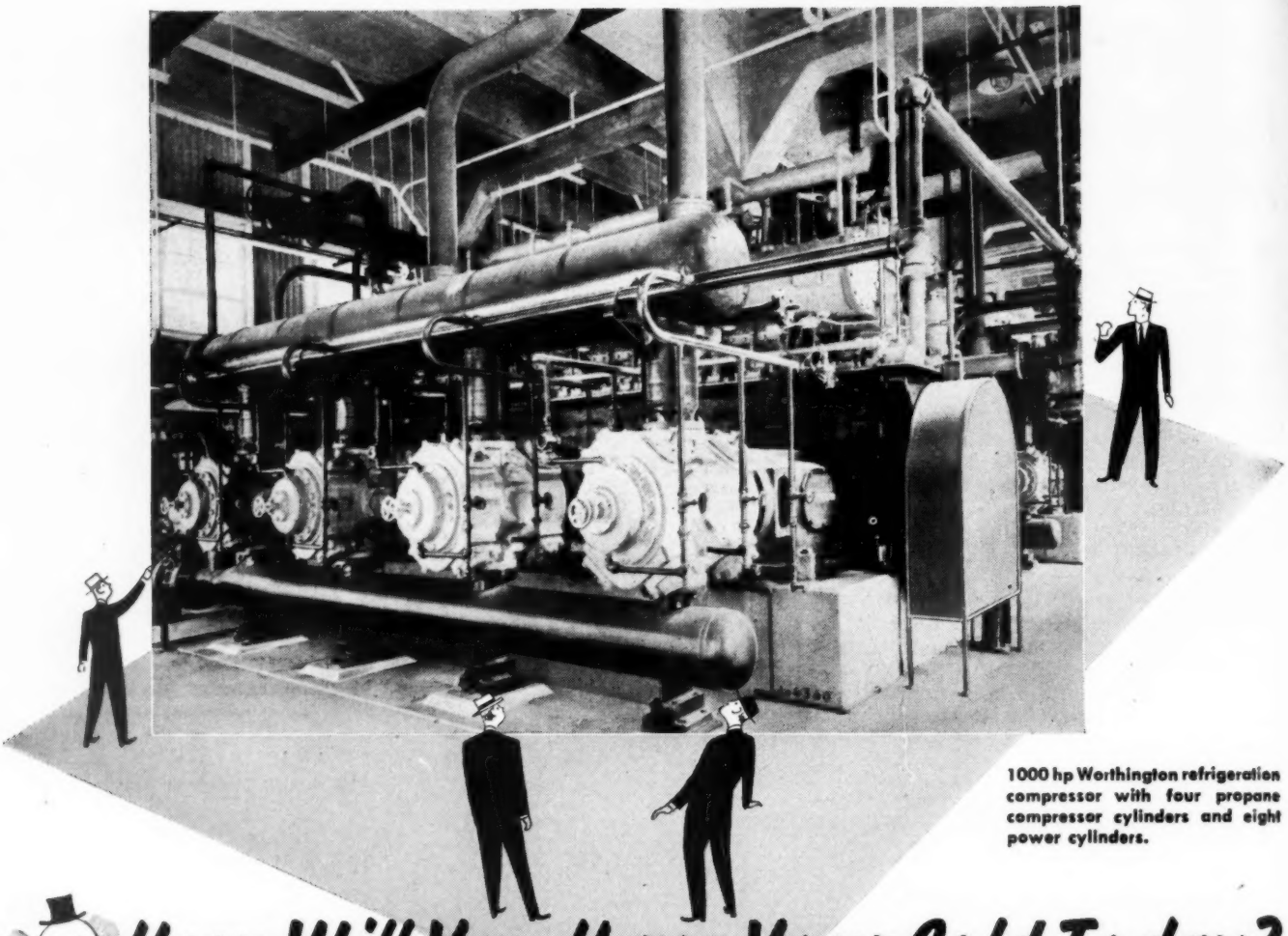

1000 hp Worthington refrigeration compressor with four propane compressor cylinders and eight power cylinders.

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Some buying notes on refrigeration compressors in the 150 to 1000 tons range

The right size. For anything between 150 to 1000 tons . . . between 400 and 1000 bhp . . . you'll find a Worthington gas engine-driven compressor that hits your requirements on- or close to-the-nose.

The right design. It will be compact and well-balanced, with compressor and power cylinders mounted on an angle-type frame, using a common large-diameter crankshaft.

The right construction. Such features as solid bore power cylinders (fully jacketed with directed water to hottest parts) and heat-treated steel forged connecting rods.

The right lubrication. Full pressure feed to bearings, cylinders and packing . . . cast-in oil manifold . . . connecting rods rifle-drilled for lubrication.

The right packing. Exceptionally deep packing boxes fitted with metallic full-floating type piston rod packing —vented and lubricated.

The right valves. Large area Worthington Feather* Valves—lightest, tightest, quietest ever made—in suction and discharge.

The right "easy-maintenance" features. Power and compressor rods identical and interchangeable . . . shim-adjustable babbit-lined steel main and crankpin bearings . . . famous Worthington easy-on, easy-off, always-tight QD sheaves.

The right safety features. Shutdown controls for overspeed, oil pressure failure, excessive water jacket temperature.

In a word—it's the *right* machine for the job, demonstrating again that *there's more worth in Worthington.* Bulletin C-1100-B21 tells more; address *Worthington Pump and Machinery Corporation, Harrison, New Jersey.*

WORTHINGTON

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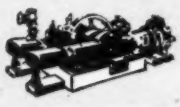
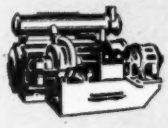
Horizontal compressors for all types of refrigerants

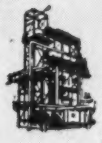


Shell and tube refrigerating equipment

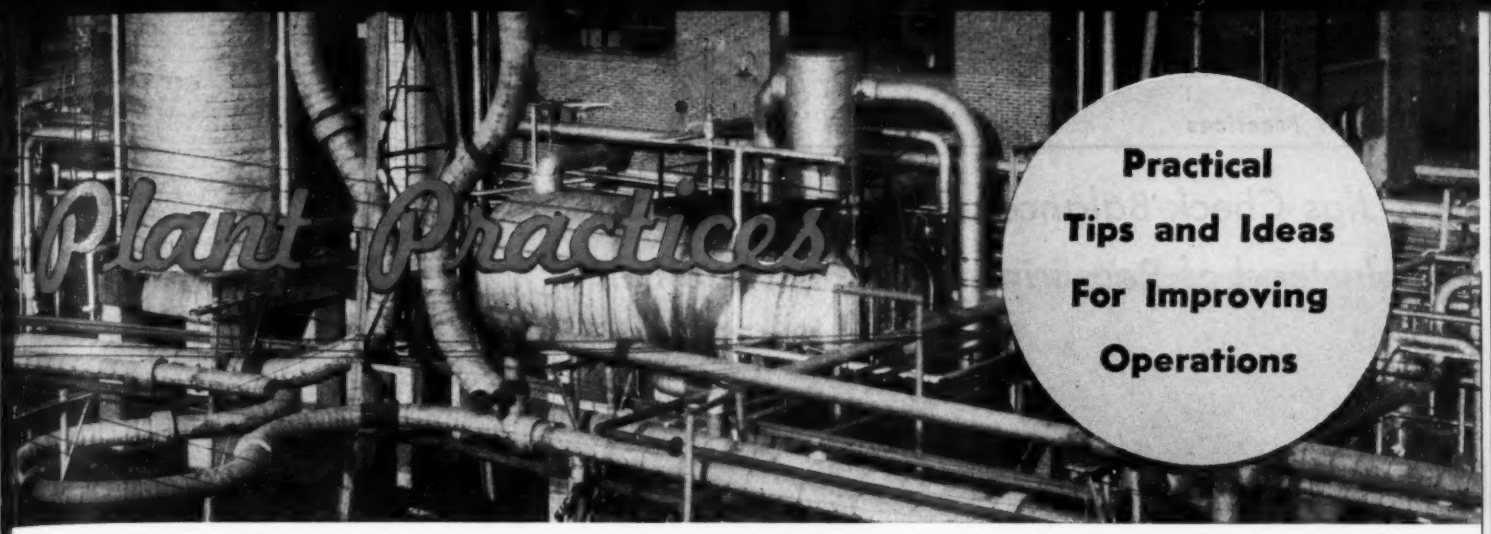
Centrifugal compressors



Absorption refrigerating machines



Chilling machines and exchangers



Pump Valve Seats Are Refaced on the Job Using Air Motor-driven Portable Grinder

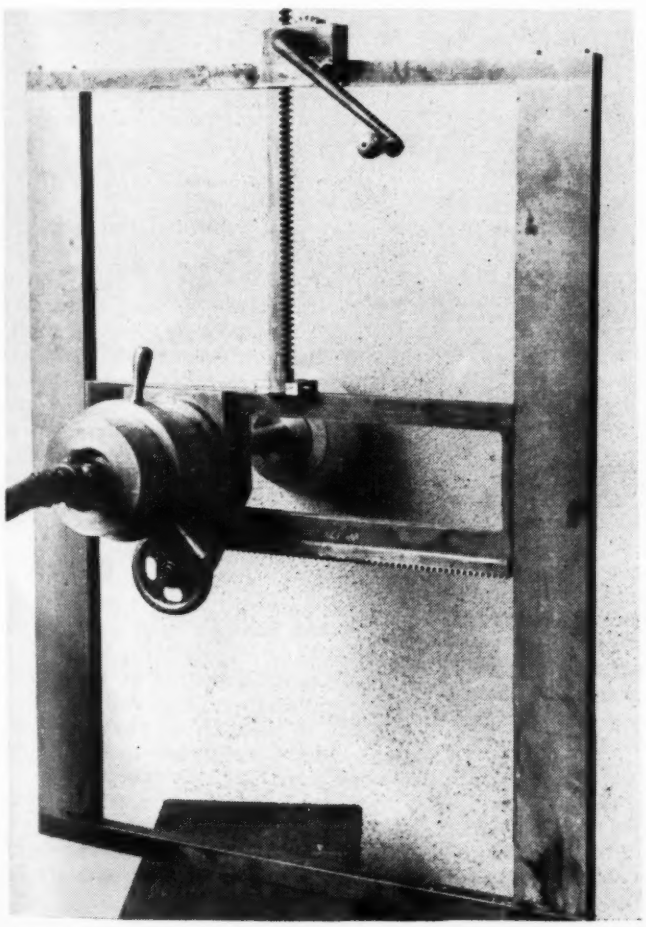
By R. C. STEINHOFF, Ass't. Master Mechanic
Sinclair Refining Co., Houston, Texas

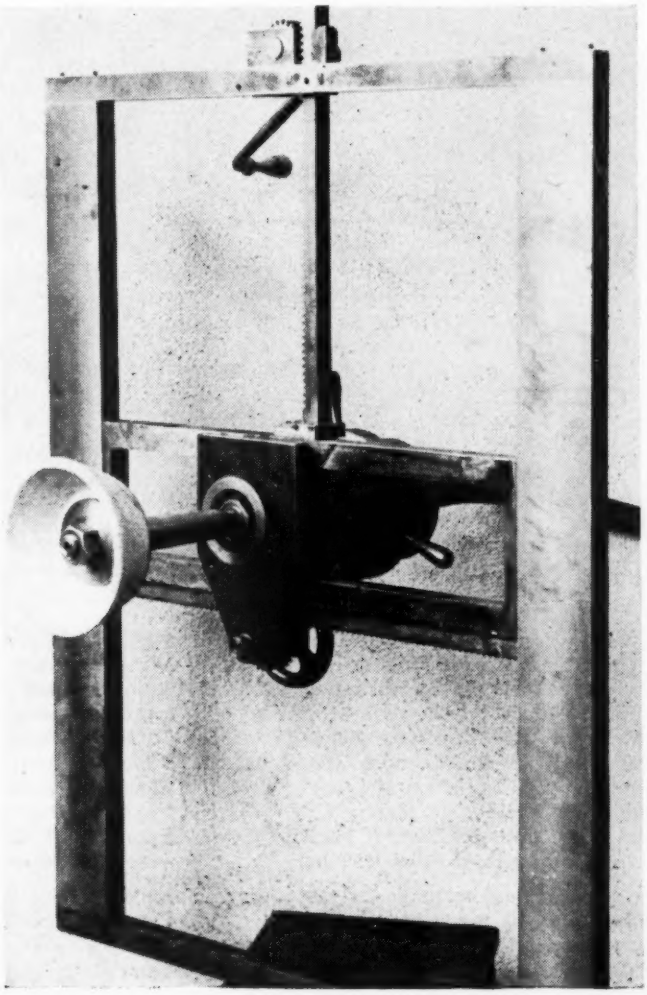
THE portable valve grinder shown in the accompanying photographs was designed to reface steam cut-off valve seats on steam pumps on which the steam chest is cast integral with the steam cylinder. In order to reface these seats in the conventional practice without a portable grinder, it would be necessary to dismantle the pump, remove the steam cylinder, reface in a planer, and then reassemble, realign, and regrout the pump.

With the portable grinder, the same thing can be accomplished by bolting the machine to the steam chest and refacing the seats, after the steam chest cover has been removed. Openings to the steam cylinder are sealed off to prevent any grindings from entering that part during the refacing operation.

The grinder consists of an angle iron frame with a suitable adjustable rack for positioning it. The grinder is driven by a 2-3/8 in. air-drive tube cleaner motor. The grinding wheel is fed into the valve seat by means of the feed head shown. The tool has proved very satisfactory and has reduced considerably the cost of refacing this type of valve.

Photographs below and at right show front and back views of portable valve seat grinding machine





Jigs Check Balance of Shafts on the Spot Instead of Requiring Time on Shop Lathes

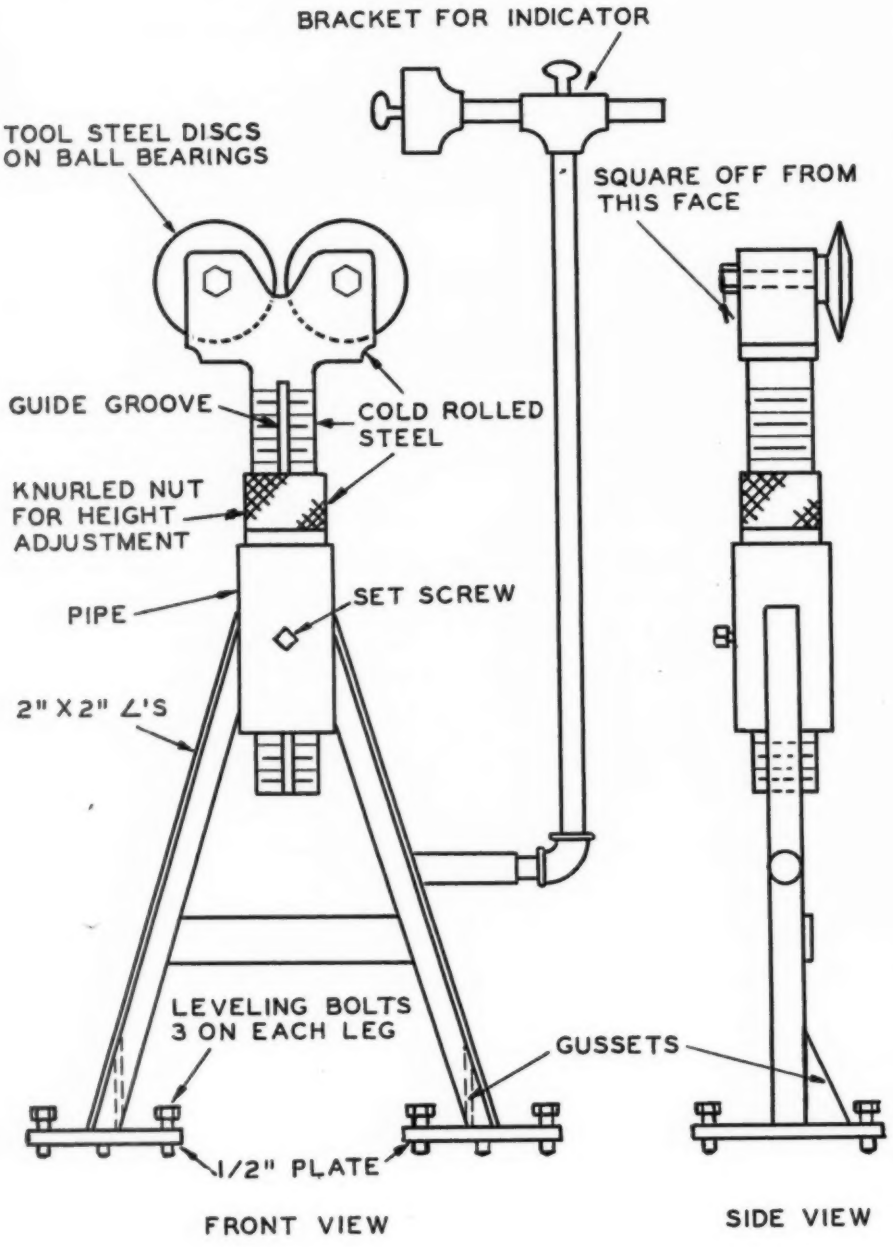


Fig. 1—Front and side views of one of a pair of jigs used at Socony's East Chicago plant for balancing heavy shafts in the field

PORTABLE balancing jigs or brackets, used in pairs, enable the maintenance department at Socony-Vacuum Oil Co.'s East Chicago refinery to perform most shaft balancing jobs right on the spot without completely disassembling the unit and taking the shaft back to the shop to be balanced on a lathe.

In this way, a quick but necessary check can be made in the field, keeping shop lathes free for other work. The balancing devices are used on a number of heavy jobs; for example, rotors on 100 hp. motors, shafts on large centrifugal oil pumps, and blower fans in the boiler house. It is very important that these units be maintained in good balance and running smoothly because of the potential hazard and the equipment damage which could result.

Front and side views of the device are shown in the simplified sketch in Fig. 1. Three stud bolts in each base plate provide for leveling the unit. The tool steel, knife-edge discs are the support for the shaft being tested. They are parallel to the face on the cold-rolled steel, bearing piece in which they are mounted on ball bearings. These faces are squared off between each of the pair of jigs when in use.

A framework of pipe, welded to one leg, serves as a bracket for mounting the indicator. It is adjustable for various jobs by means of the two Tees and set screws.

Supply Remote Shut-off to Pump By Magnetic Device on Governor

A MAGNETIC mechanism connected to the regular over-speed trip serves as a remote-controlled, emergency shut-off for steam turbine-driven centrifugal pumps handling charge stock to furnaces at the Hancock Oil Co. refinery in Long Beach, Calif.

The magnetic switch is installed in a dust-proof case beneath and at one side of the governor on the end of the turbine drive shaft. It is connected to the over-speed trip by a length of steel cable drawn to tension by means of a spring.

Through approved conduit, an electrical connection is made from the switch to a push button on the control panel in the plant instrument room. In case of fire, or at any time when the pumps must be shut down quickly, the operator simply pushes this button. The magnetic switch then trips the cable, and the spring draws the overspeed to the closed position, shutting the steam valve, and stopping the turbine.

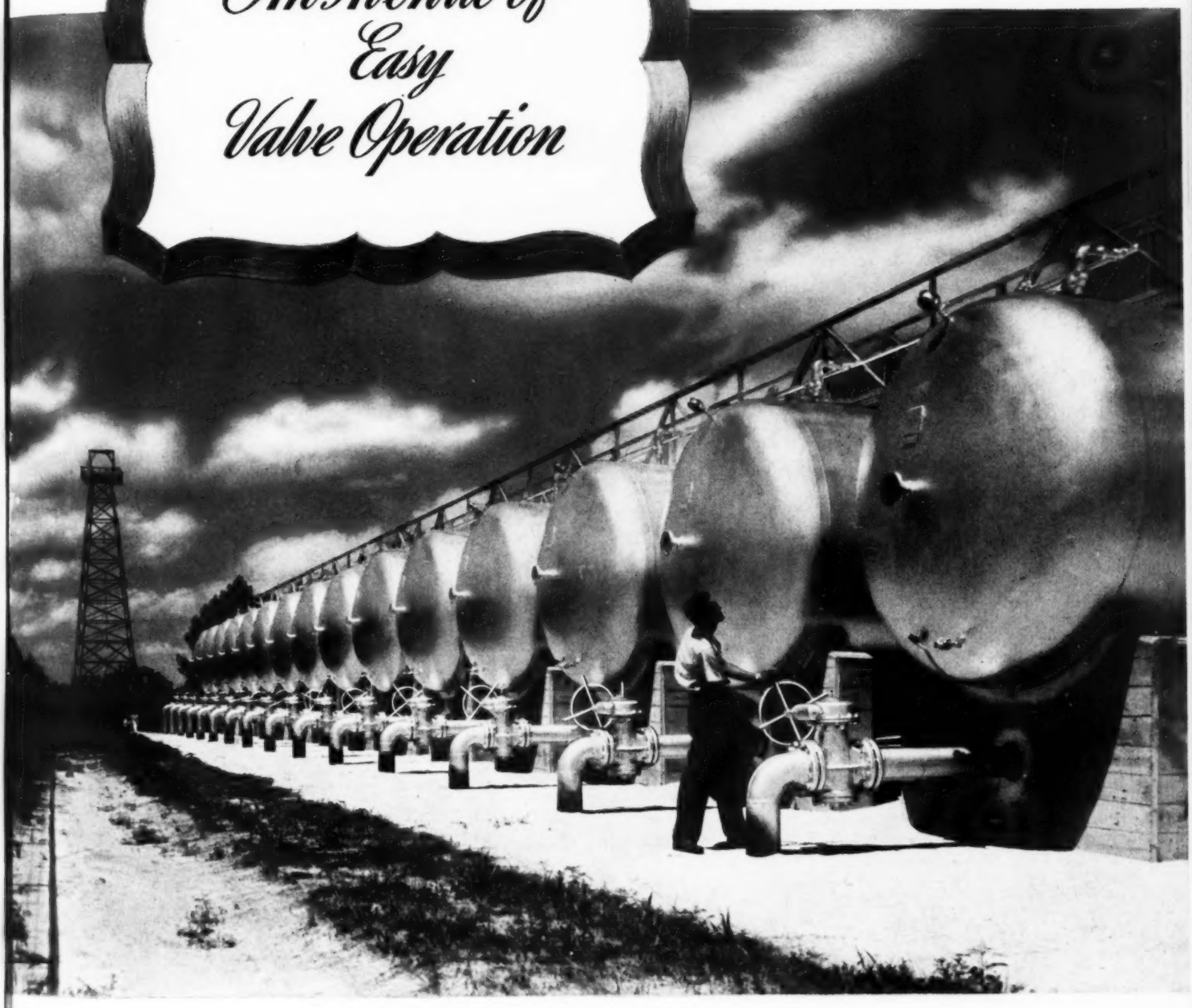
Enclose Instrument Tubing in Conduit to Prevent Corrosion

PREVENTION of corrosion and other damage to copper tubing in the instrument system of Wilmington Gasoline Co.'s plant at Terminal Island, Calif., is accomplished by carrying the tubing from instrument to instrument in metal conduit similar to that used for the protection of electrical wiring.

The annealed copper tubing is passed through the required length of conduit, which is then bent to shape for passing around fittings and equipment located between the instruments or valves being connected. Supports are provided at the necessary points to stiffen and hold the conduit in position so that the copper tubing merely rests inside free of clamps and other attachments.

The conduit affords a double protection because the tubing is enclosed and cannot be damaged by wrenches, and because no contact by air is permitted.

An Avenue of Easy Valve Operation

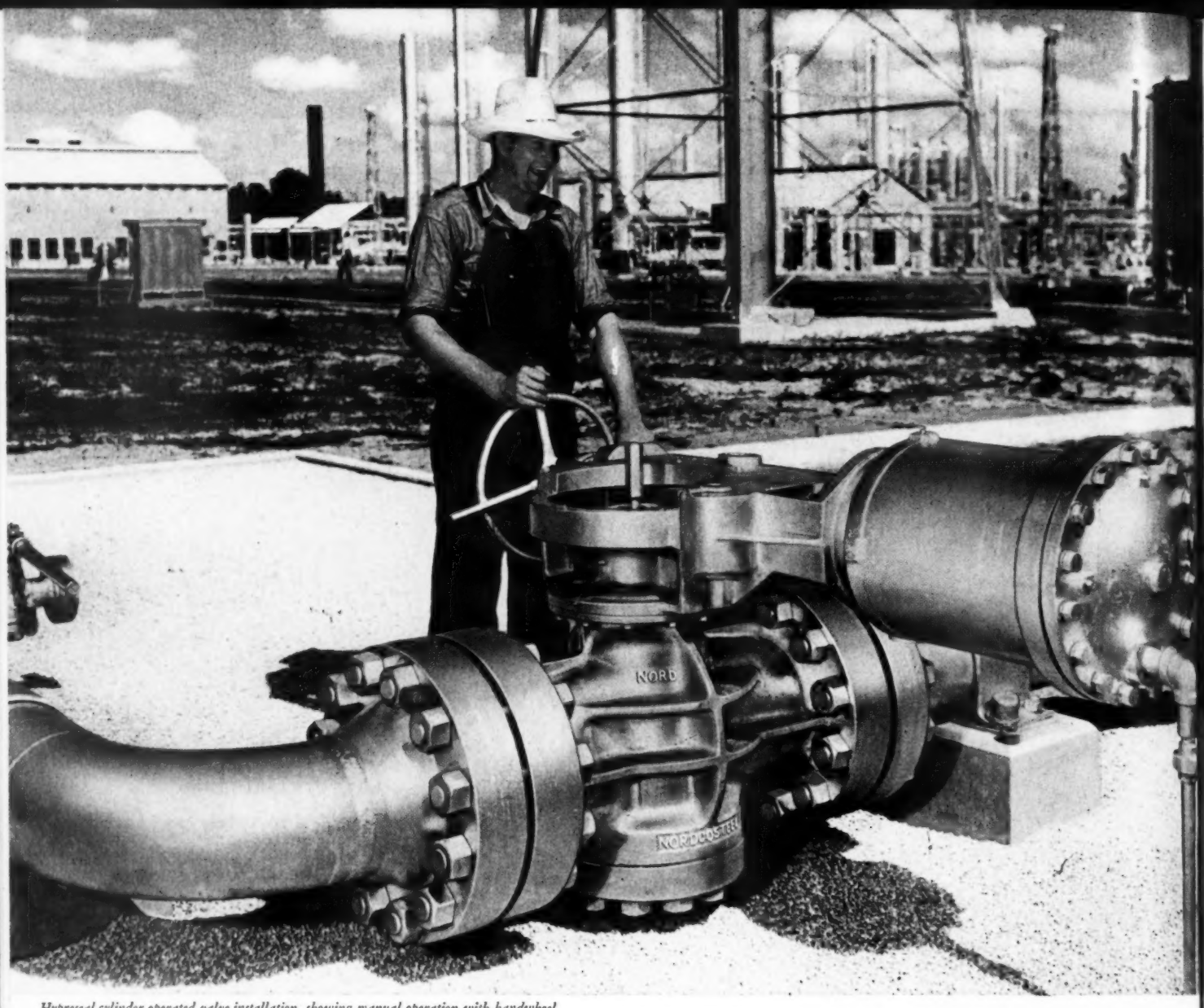


YOUR tanks may not be butane tanks like those in the picture, but they need safe, easily-operated valves just as much, no matter what they hold. Exposed to the elements, Nordstrom valves are weatherproof. Their simple quarter-turn is time-saving, especially where there's a long row to operate. But more important, Nordstroms will not stick or gall, leak or corrode. The tapered rotary plug, seated on a film of lubricant, turns easily. A thin coating of lubricant, injected under pressure higher than that of the line, seals each port against leakage. Nordstroms are the *best* valve equipment for your lines.

Use *genuine* Nordcoseal lubricants.

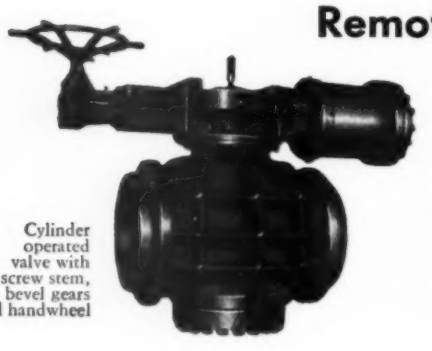
Nordstrom

LUBRICATED VALVES



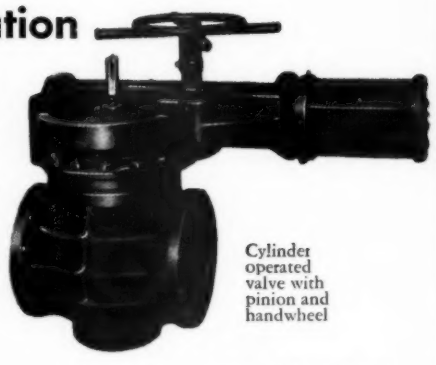
Hypreseal cylinder operated valve installation, showing manual operation with handwheel.

Remote Control or Hand Operation



Cylinder operated valve with screw stem, bevel gears and handwheel

For both power control and hand operation, there's a full range of cylinder-equipped Nordstrom valves. The design permits panelboard control from a remote central point or local manual operation. Air, gas, oil, water, and in many cases fluid in the main piping system, may be used as the operating medium. Electric motor operating units can also be furnished. Nordstrom field engineers everywhere can give you full details.



Cylinder operated valve with pinion and handwheel

Keep Upkeep Down
Use *genuine*
Nordcoseal lubricants

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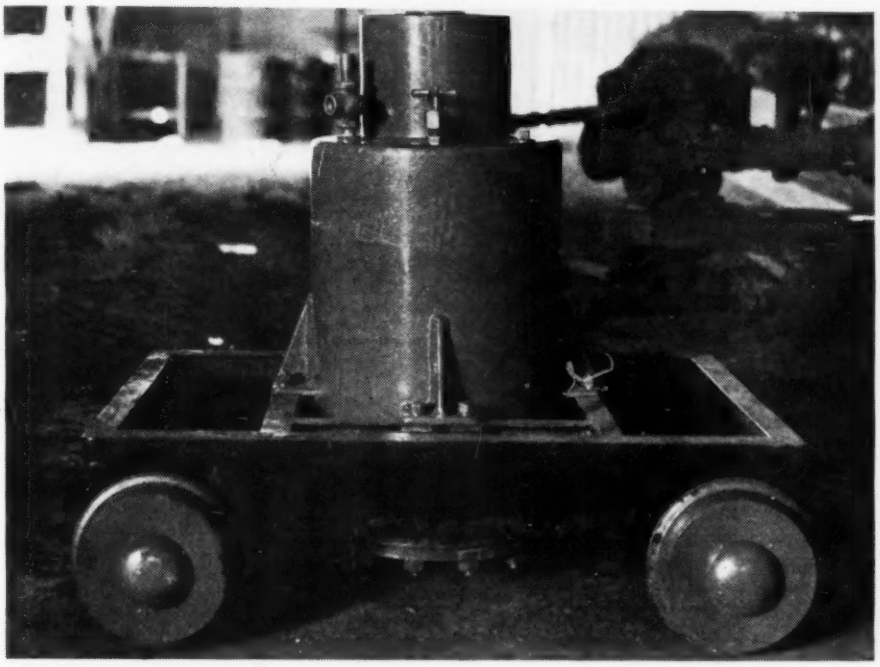
Three-ton Jack Removes Bottom Heads from Polyformer Unit

TO FACILITATE removing heavy bottom heads from the 6 reactors in the polyforming unit—each head weighs about three tons—Sinclair engineers at the company's East Chicago refinery developed the special hydraulic jack shown in the accompanying photograph.

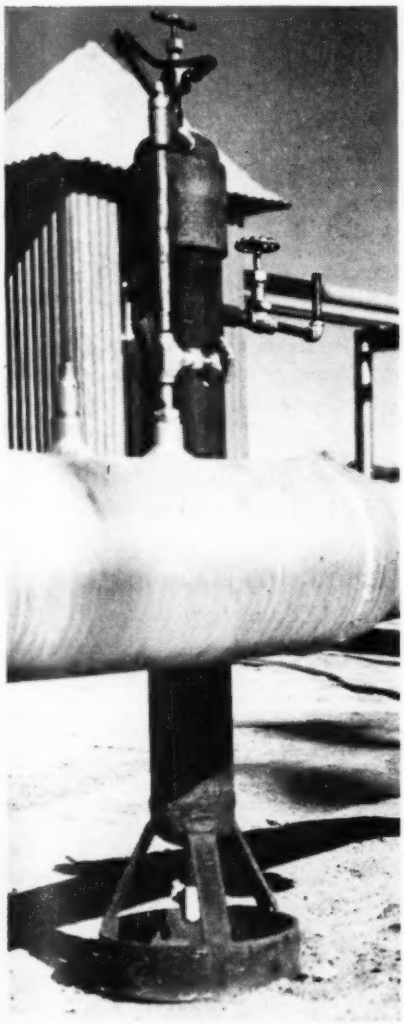
Designed for close clearances, both horizontally and vertically, the jack is mounted on a small steel car which runs along the railroad tracks under the reactors. It consists of a telescoping arrangement of 3, 6, 10, and 18-in. pipe. The largest diameter pipe serves as the oil reservoir and is fitted with a small line for quick connection to the plant compressed air line.

A socket inside the top cylinder fits a boss of bar stock welded at the center of the reactor bottom head. The unit can also be extended as a secondary jack to reach up inside the reactor for lowering the relatively lighter internal accessories.

The maintenance department liked the rugged little jack so well it is building three more.



Sinclair's heavy-duty hydraulic jack handles loads up to three tons



Scrubber Dries Gas Samples Thoroughly, Is Made of Six-inch Pipe and Fittings

By JOHN C. ALBRIGHT

ALL TRACES of water vapor are thoroughly removed from samples of gasoline plant processing gas at the time the sample is obtained, in a portable device in use at the Terminal Island, Calif., plant of Wilmington Gasoline Co. The method uses a small vertical scrubber filled with a drying agent, or steel wool, and located beside the header where samples are most frequently taken.

The scrubber body is made of 6-in. pipe. A head welded to the bottom carries a bleeder valve. The top has a collar into which a plug is screwed carrying fittings to receive the gas from the header. A pipe extends down through the packing so that condensate will be discharged into the space above the bleeder valve.

All gas for the sample flows upward through the scrubber packing to a side connection to which a sample bomb is attached with standard fittings. A ring cut from a piece of scrap pipe of larger diameter than the scrubber is welded by means of 4 legs of metal to the bottom, and serves as a support. The scrubber-sampler can be taken around the plant from job to job.

Left: combination gas sampler and scrubber for moisture-free samples

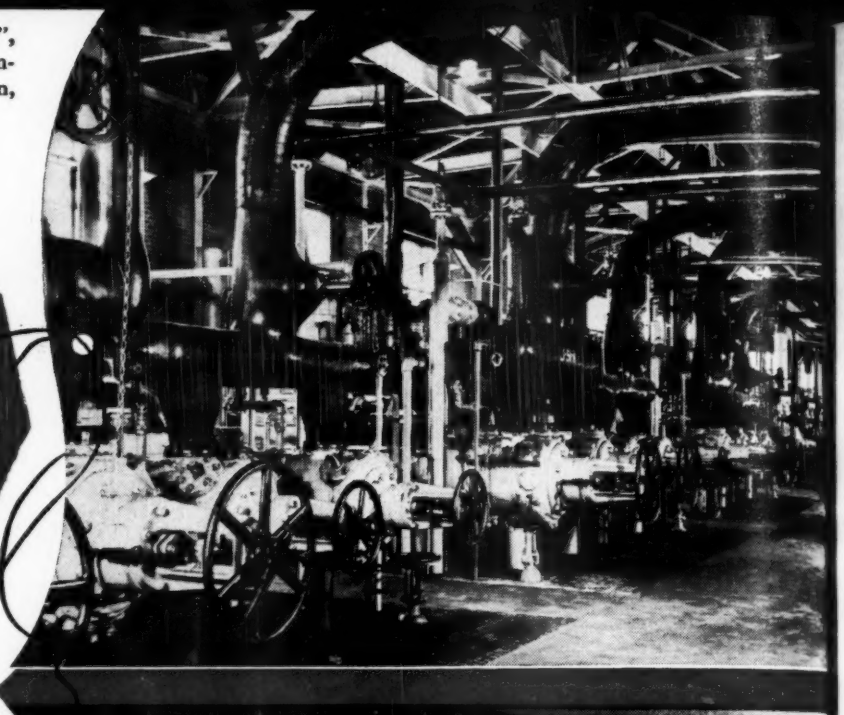
IDEAS—Wanted!

Plant operators, foremen, engineers, superintendents!—Send in your own original contributions on "how we do it around our refinery." Possible subjects could include operating short-cuts, time and money-saving gadgets, special repair tools, accident and fire prevention ideas. Please include photographs, drawings, and charts if available.

Material submitted for publication exclusively in PETROLEUM PROCESSING is paid for at the regular space rates. The idea is the thing—we'll dress up the drawings and the written information. Send your ideas to:

Plant Practices Editor
PETROLEUM PROCESSING
1213 West Third Street
Cleveland 13, Ohio

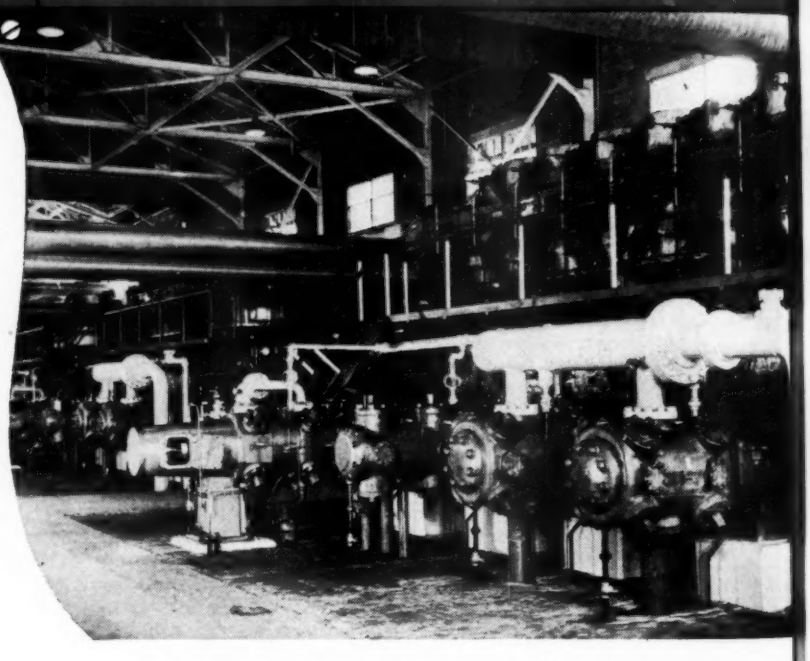
6 Clark 6-cyl., 600 B.H.P., "Right Angle", gas-engine-driven compressors in Commercial Solvents Corp. plant at Sterlington, Louisiana.



COMMERCIAL SOLVENTS PLANT

typifies multi-purpose use of

CLARK COMPRESSORS



8 Clark 8-cyl., 2,790 B.H.P., steam-engine-driven compressors pump gas from atmospheric to 5,200 pounds pressure.

• In the big ammonia and methanol plant of Commercial Solvents Corporation at Sterlington, La., 35 Clark Compressor units are employed for a variety of purposes.

Taking the gas at atmospheric pressure, 8 Unaflow Compressors—Clark steam-engine-driven, 8-cylinder units developing 2,790 B.H.P. each—pump it up to 5,200 pounds pressure.

Twelve 3-cylinder steam compressors take the high-pressure gas and recirculate it through the catalyst chambers or reactors.

The other 15 Clark Compressors in this plant are of the famous 2-cycle, "Right Angle", gas-engine-driven type, in capacities of 300, 600 and 800 B.H.P. Some are used for cooling and condensing the ammonia after it is made and the rest for pumping gas for miscellaneous services.

Clark's complete line of gas, steam and electric-driven compressors, including multi-stage Centrifugals, provides the right answer for practically every requirement, and with the utmost economy consistent with good engineering. Let us consult with you about your next project.

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SETS THE PACE IN COMPRESSOR PROGRESS

Refinery Tools for the Manufacture Of High-Octane Gasoline

By T. B. KIMBALL and J. A. SCOTT
Sinclair Refining Co., New York

Various methods available with present refinery facilities for producing high-octane gasolines are reviewed from the point of view of their application by smaller refineries to maintain their competitive positions. Improved straight-run fractionation and reforming are emphasized. Improvements which can be made by Polyforming in place of thermal reforming are discussed, also the effect of replacing thermal cracking with catalytic cracking on the heavier fractions of the crude. Supplementing of catalytic cracking with thermal cracking of the catalytic cycle stocks for maximum yield of high-octane gasoline is included.

The alternate use of catalytic polymerization vs. alkylation for processing of propane and butylene fractions is reviewed. The large increases in yields shown can only be accomplished at increased costs.

THE war-time demand for aviation gasoline resulted in extensive expansion of catalytic cracking, alkylation and other high octane gasoline producing facilities in many of the country's refineries. Due to transportation problems and availability of selected types of crudes, most of this expansion took place on the Pacific Coast, Gulf Coast and, to a lesser extent, in the Eastern Seaboard refineries. At the close of the war, these facilities immediately became available for producing high octane motor gasoline. As a result, these sections of the country have been able to produce greater yields of high octane gasoline than the Mid-Continent and Great Lakes area where war-time expansion was not as extensive.

Following the war, many companies have been carrying out refinery expansion programs to bring refineries in the Central area in line with those of the Coastal areas. However, a large number of refineries, particularly the smaller ones, still faced with the problem of competing with these new facilities both as to increased gasoline yields and higher octanes.

Sinclair Refining Co. installed three catalytic cracking processes, namely, Houdry, Fluid and Thermofor, as part of the war-time facilities for producing aviation gasoline. The company also has in operation both alkylation and polymerization units. The purpose of this paper is to compare the yields and octanes resulting from refining by these methods with typical thermal-type of operations. One case showing the improved results from substituting Polyforming* for thermal reforming is also included.

A brief description of each scheme of refining used in the comparison follows:

Case I—Represents a typical prewar refinery operation with normal crude topping, thermal reforming of the 300-400° F. naphtha and thermal cracking of the heavy fractions.

Case II—Same general scheme as Case I, except that the straight-run gasoline is fractionated to a close cut 90% at 200° F. overhead, and the 200-400° F. naphtha is reformed thermally with thermal cracking of the heavy fractions.

Case III—Similar to Case II, except that the 225-400° F. boiling range straight-run naphtha is Polyformed using the thermal C_3 and C_4 fractions as extraneous feed to the Polyform unit.

Case IV—The thermal cracking of the gas oil fraction is replaced by Thermofor catalytic cracking and the thermal reforming limited to a 265-400° F. naphtha.

Case V—Similar to Case IV, except that Fluid cracking with synthetic catalyst is substituted for Thermofor catalytic cracking and the thermal reforming adjusted to the processing of a 275-400° F. naphtha.

Case VI—Similar to Case V, except that natural catalyst is used in the Fluid catalytic cracking.

A review of present-day octane standards indicates that an average 77 Motor with an 83 Research is satisfactory as a competitive gasoline in the regular grade, and an 80 Motor with 88 Research quality for the premium grade. The data also indicates that a ratio of 35% premium to 65% regular prevails throughout most of the country. The gasolines produced in these several cases were, therefore, set up on this basis and were leaded to an average weighted octane of 84.7 Research with 78 Motor as representing a gasoline meeting the above octane standards.

In all cases except I, the amount of straight-run gasoline to be blended and the naphtha to be reformed were varied to meet this stipulated 6.7 octane spread. In Case I, with minimum reforming of 300-400° F. naphtha, tetraethyl lead was added to meet 84.7 Research with Motor method to fall, resulting in a 4.3 spread and requiring 2.8 cc's of tetraethyl lead. The maximum use of lead in the other cases will result in gasolines of 90 Research octane and, by adjustment of reforming in the catalytic cracking cases, these gasolines can approach 95 Research oc-

*Polyform yield and octanes were supplied by courtesy of the Gulf Oil Corp.

THE AUTHOR

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tane with a 10 sensitivity with, of course, a corresponding reduction in gasoline yield.

In order to compare yields and octanes, the cases were set up on the basis of refining typical Sinclair pipe line crude of 5-6 lb. RVP and of 35-36 gravity containing approximately:

30% 400° F. End Point Gasoline
10% Kerosine
15% Diesel Fuel
45% 23° Gravity Reduced Crude

In view of the present-day demand for fuel distillates, it is assumed that the kerosine and Diesel fuel can be disposed of profitably and would not be available as cracking stock. The cracking operation is, therefore, limited to processing the 45% reduced crude bottoms. In Cases I, II and III, this reduced crude is processed in a typical Sinclair pressure pipe still operation, which consists of charging the reduced crude hot, either from the crude still or through a pre-heater, directly into the gas oil evaporator, thereby providing clean gas oil heater feed.

The reduced crude bottoms and cracked tar from the gas oil evaporator are subsequently evaporated under vacuum to an asphalt-type bottoms and the evaporator overhead charged back to the cracking system to augment the heater feed. Sufficient cycle oil is withdrawn from the bubble tower side stream stripper to furnish cut-back of the asphalt bottoms for meeting maximum 12 API gravity fuel specifications of average 150 SF vis at 122° F.

In Case IV, the reduced crude is charged as such to the Thermofor catalytic cracking unit, where it is flashed to a 15% bottoms on crude and the 30-31 gravity overhead gas oil is superheated for reactor feed. In Fluid Cases V and VI, the 45% reduced crude is flashed by vacuum distillation to a 10% asphalt bottoms on crude, with the 27-28 gravity gas oil overhead being used as feed stock to the reactor.

In all catalytic cracking cases, the catalytic cycle oil is cracked thermally to maximize gasoline production. During the winter months, increased house heating oil demands might dictate the sale of the light 50% portion of this cycle oil as distillate fuel, but in certain sections of the Mid-Continent area sales of house heating oil would be difficult and, for the purpose of this comparison, maximum distillate yields as house heating oils have been neglected.

The three catalytic cracking cases are set up on a 60% conversion basis supplemented by thermal cracking of the cycle oils. A previous study of yields indicated this to be the optimum conversion level for maximizing yield of gasoline when polymerizing the lighter olefins. Above 60% conversion the discard of the saturated C_4 fractions to fuel for gasoline vapor pressure control is excessive, unless alkylation is substituted for polymerization in processing these light hydrocarbons. If alkylation is employed, the catalytic cracking conversion level can be in the order of 65-70% for maximum yield of gasoline.

In all cases except III, the gasoline distillates, both reformed and cracked, are stabilized to a C_5-400° F. stabilizer bottoms, and the C_3 and C_4 fractions processed in a catalytic polymerization unit at an 85% olefin conversion level. The raw polymer is subsequently stabilized for butane rejection to meet 10 lb. vapor pressure on total gasoline. In Case III, Polyforming is substituted for reforming and cracked C_3 and C_4 fractions are charged as extraneous gas feed to the Polyform unit. The Polyform operation is carried out on a 100% gas recycle basis (1:1 ratio of gas recycle to naphtha feed).

The detailed yields for each of these cases have been worked out and presented in tabulated form. A summary of yields is presented in Table 1. Octanes and vapor pressure of the individual components used in the gasoline blend are given in Table 2. Table 3 is a summary showing the composition and octane characteristics of the blended gasolines.

Since most of the large refiners have either installed facilities for making high-octane gasoline or have definite plans for so doing, the purpose of this paper is to review what might be done by the small refiner. Therefore, these yield comparisons have been arbitrarily set up on the basis of a 5000 b/d crude run.

TABLE 1—Summary of Product Yields on Crude

	Case I 300-400 Naphtha Reform % Yields	Case II 200-400 Naphtha Reform % Yields	Case III Naphtha Polyform % Yields	Case IV TCC Natural Catalyst % Yields	Case V Fluid Synthetic Catalyst % Yields	Case VI Fluid Natural Catalyst % Yields
Premium Gasoline	15.5	14.4	14.8	16.0	16.7	17.7
Regular Gasoline	28.9	26.7	27.6	29.7	30.9	33.0
Total Gasoline	44.4	41.1	42.4	45.7	47.6	50.7
Kerosine	10.0	10.0	10.0	10.0	10.0	10.0
Diesel Fuel	15.0	15.0	15.0	15.0	15.0	15.0
Total Gasoline and Distillates	69.4	66.1	67.4	70.7	72.6	75.7
Fuel and Gas	30.5	33.1	31.9	28.4	26.5	24.0
Refinery Loss	0.1	0.8	0.7	0.9	0.9	0.3
Total Products	100.0	100.0	100.0	100.0	100.0	100.0

In Case I the minimum reforming of 300-400° F. naphtha and the blending of 330° F. end-point straight-run gasoline results in a gasoline yield on crude of 44.4%, or a total light oil recovery of 69.4%. This gasoline requires 2.8 cc's of lead to meet the 84.7 Research average octane selected and, with susceptibility of 4.3, results in a Motor octane of 80.4. Thus it is shown that by the use of lead, such gasoline can meet the present competition in the Mid-Continent area. However, such a gasoline would not meet the probably higher future octanes of the Coastal and Eastern Seaboard areas because of its maximum use of lead.

In Case II, the 330° F. end-point gasoline is rerun to recover an overhead fraction boiling 90% at 200 for blending directly into gasoline, and the resulting 200-300° F. naphtha is reformed along with the heavier naphtha for production of high-octane gasoline. The gasoline yield, in this case drops to 41.4% on crude and the total light oil recovery to 66.6%. This gasoline requires 0.85 cc's of lead to meet the 84.7 Research octane and has a 6.7 sensitivity. The more intensive reforming results in some discard of C_4's to fuel even after polymerization.

In Case III the light straight-run gasoline is cut to a higher end point than in Case II, and the thermal reforming replaced by Polyforming of a 225-400° F. naphtha. The Polyform feed is supplemented by charging as extraneous feed all of the C_3 and C_4 fractions from the thermal cracking of gas oil, and the gas recycle is set up on a 100% basis. The gasoline yield on crude when Polyforming is increased from 41.4% in

TABLE 2—Characteristics of Gasoline Components

	RVP	—Motor Octanes— Clear	—Motor Octanes— 3 cc TEL	—Research Octanes— Clear	—Research Octanes— 3 cc TEL
St. Run Gaso. (225 E.P.)	15.0	73.0	88.0	74.0	89.0
St. Run Gaso. (330 E.P.)	10.5	62.0	81.0	63.0	82.0
Reform Gaso. from 300-400 Naphtha	4.5	68.0	81.0	75.0	89.0
Reform Gaso. from 200-400 Naphtha	4.5	72.0	82.0	82.0	92.0
Thermal Gaso. 400 E.P. from Virgin Gas Oil	4.5	66.0	76.0	73.0	84.0
Thermal Gaso. 400 E.P. from Cat. Cycle	4.5	68.0	76.5	74.5	85.0
Polyform Gaso. 400 E.P.	10.0	77.0	84.0	87.0	94.0
TCC Gaso. (Natural Catalyst) 410 E.P.	7.0	78.0	86.0	89.0	96.0
Fluid Gaso. (Natural Catalyst) 410 E.P.	6.0	78.0	83.0	91.0	96.0
Fluid Gaso. (Synthetic Catalyst) 410 E.P.	7.5	81.0	86.0	93.0	97.0
*Polymer Gaso. 400 E.P.	2.7	100.0	101.0	115.0	116.0

* Octane blending value.

CASE I—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10#RVP Gasoline Yields Based on Thermal Reforming of 300-400 Naphtha and Thermal Cracking of 45% Reduced Crude to 12 API Fuel Gravity

	Crude Topping		Thermal Reforming (300-400)		Thermal Cracking		Cat. Poly. 85% Conv.	Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	B/D	%
$=C_3$ to Cat. Poly.	...	...	5	1.4	16	0.7			
iC_4	...	...	4	1.0	11	0.5	15		
$=C_4$	...	...	14	4.0	43	1.9	9		
nC_4	...	...	12	3.4	36	1.6	48		
Total B-B to Cat. Poly.	...	...	30	8.4	90	4.0	72	72	
S.S. Gaso. 330 E.P.	1100	22.0	...	...	...	...	...	1100	
Reform (C_5—400)	...	...	250	71.5	...	...	...	250	
Thermal (C_5—400)	...	...	...	...	756	33.6	...	756	
Polymer	...	...	...	...	...	...	53	53	
Total Raw Gasoline	...	...	...	...	...	...	...	2231	
Treated Gasoline	...	...	...	...	...	...	...	2220	44.4
Naphtha to Reform	350	7.0	...	...	...	...	...	...	...
Kerosine	500	10.0	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	750	15.0
Total light oil yield	...	...	...	...	...	...	...	3470	69.4
Reduced Crude to Thermal	2250	45.0	...	...	...	...	...	...	...
Cycle Oil (Fuel)	...	...	...	...	112	5.0	...)		
Thermal Tar	...	...	30	8.6	1193	53.0	...)	1335	26.7
Gas (F.O.E.)	25	0.5	30	8.6	135	6.0	2	192	3.8
Gain (—), Loss (+)	+25	+0.5	+5	+1.5	—52	—2.3	+14	+3	+0.1
Total	5000	100.0	350	100.0	2250	100.0	141	5000	100.0

CASE II—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10# RVP Gasoline Yields Based on Improved Fractionation of the Straight Run Gasoline with Thermal Reforming of 200-400 Naphtha and Thermal Cracking of 45% Reduced Crude to 12 API Gravity Fuel

	Crude Topping		S.R. Gaso. Rerun		Thermal Reforming (200-400)		Thermal Cracking		Cat. Poly. 85% Conv.	Stab. for R.V.P.	Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	%	B/D	B/D	B/D	%
$=C_3$ to Cat. Poly.	...	...	...	...	16	1.8	16	0.7				
iC_4	...	...	...	...	12	1.3	11	0.5	23	14		
$=iC_4$	...	...	...	...	46	5.1	43	1.9	13	8		
nC_4	...	...	...	...	34	3.8	36	1.6	70	94		
Total B-B to Cat. Poly.	...	...	...	...	92	10.2	90	4.0	106	66	66	
Lt. S.R. Gaso.	...	...	550	50.0	...	...	...	...	...	...	550	
Reform (C_5—400 E.P.)	...	...	...	...	612	68.0	...	...	...	...	612	
Thermal (C_5—400 E.P.)	...	...	...	...	...	...	755	33.6	...	...	755	
Polymer	...	...	...	...	...	...	...	...	82	...	82	
Total Raw Gaso.	...	...	...	...	...	...	...	...	...	...	2065	
Treated Gaso.	...	...	...	...	...	...	...	...	...	...	2055	41.1
S.R. Gaso. 330 E.P.	1100	22.0	...	...								
Naphtha to Reform	350	7.0	550	50.0								
Kerosine	500	10.0	...	...	...	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	...	...	...	750	15.0
Total light oil yield	...	...	...	...	...	...	...	...	...	...	3305	66.6
Reduced Crude to Thermal	2250	45.0	...	...								
Cycle Oil (Fuel)	...	...	...	...	...	...	112	5.0	...	...)		
Thermal Tar	...	...	...	...	72	8.0	1193	53.0	...	...)	1377	27.5
Gas (F.O.E.)	25	0.5	...	...	90	10.0	135	6.0	3.0	25	278	5.6
Gain (—), Loss (+)	+25	+0.5	...	...	+18	+2.0	—51	—2.3	+23	+15	+45	+0.8
Total	5000	100.0	1100	100.0	900	100.0	2250	100.0	214	106	5000	100.0

CASE III—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10 lb RVP Gasoline Yields Based on Polyforming of Straight Run 225-400 Naphtha with Thermal Cracking of 45% Reduced Crude to 12 API Gravity Fuel

	Crude Topping		Straight Run Fractionation		Thermal Cracking		Polyforming (10 lb RVP Gasoline)		Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	%	B/D	%
$=C_3$ (to Polyform)	...	...	...	...	16	0.7				
C_2 (to Polyform)	...	...	...	...	32	1.4				
iC_4	...	...	...	...	11	0.5				
$=CH$	...	...	...	...	43	1.9				
nC_4	...	...	...	...	36	1.6				
Total B-B (to Polyform)	...	...	...	...	90	4.0	22	2.3	22	
Lt. S.R. Gasoline	...	...	650	60.0	...	...	...	...	650	
Thermal (C_5—400 E.P.)	...	...	...	...	755	33.6	...	...	755	
Polyform			...	...	...	...	704	75.2	704	
Total Raw Gasoline	...	...	...	...	...	...	...	...	2131	
Treated Gasoline	...	...	...	...	...	...	...	...	2120	42.4
S.R. Gaso. (330 E.P.)	1100	22.0								
Naphtha to Polyform	350	7.0	450	40.0	...	...	...	...	...	...
Kerosine	500	10.0	...	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	...	750	15.0
Total light oil yield	...	...	...	...	...	...	...	...	3370	67.4
Reduced Crude to Thermal	2250	45.0								
Cycle Oil (Fuel)	...	...	...	...	112	5.0	...	...	...	...
Thermal Tar	...	...	...	...	1193	53.0	64	6.8	1369	27.4
Gas (F.O.E.)	25	0.5	...	...	117	5.2	83	8.8	225	4.5
Gain (—), Loss (+)	+25	+0.5	...	...	—65	—2.9	+65	+6.9	+36	+0.7
Total	...	...	1100	100.0	2250	100.0	938	100.0	5000	100.0

Case II to 42.4% in Case III and the light oil recovery increased to 67.4%. The 84.7 Research octane is met with 1.2 cc's of lead and the gasoline has a 6.7 sensitivity.

In Case IV the thermal reforming is limited to a 265-400° F. naphtha and the thermal cracking of virgin stock is replaced by Thermofor catalytic cracking. The Thermofor reactor feed is obtained by charging the 45% reduced crude to the Thermofor flash tower and flashing overhead a 30-31 gravity gas oil. This results in a reduced crude bottoms of 15% on crude. The 40% Thermofor cycle oil is thermally cracked to maximize the yield of gasoline on crude. All of the condensed propylene and butylene from reforming, Thermofor and thermal cracking is polymerized at 85% conversion but, because of the relatively high yield of isobutane, a considerable amount of butanes is discarded to fuel for vapor pressure control.

The resulting gasoline yield of 45.7% on crude meets the 84.7 Research octane and 78 Motor octane with 0.6 cc's of lead. If alkylation is substituted for polymerization, the favorable isobutane-butylene balance would result in the production of 140 b/d of alkylate and the remaining butanes would be consumed in vapor pressure balancing. This modification would increase the net yield of gasoline approximately 1% on crude.

It is, of course, doubtful that an alkylation plant of this size would be economical for the small refiner. Nevertheless, this is a favorable type of operation in the larger refineries already equipped with alkylation plants, particularly in view of the present demand for aviation gasoline by the air lines and Armed Services.

In Case V, the reforming is reduced to a 275-400° F. naphtha fraction and the reduced crude is vacuum flashed to 10% (on crude) asphalt-type bottoms with the resultant heavy gas oil charged to a Fluid catalytic cracking unit. The yields are based on a 60% conversion level using synthetic catalyst and the catayltic cracking is, as in Case IV, supplemented by thermal cracking of the cycle oil for maximum gasoline production. The yield of 47.6% gasoline on crude met the 84.7 Research octane with 0.6 cc's of lead and with a 6.7 sensitivity. Because of the high isobutane production resulting from the use of synthetic catalyst, approximately 3% on crude of excess butanes is discarded to fuel. Again, if the polymerization unit is replaced by alkylation, 185 bbls. of alkylate are produced and the net increased gasoline yield on crude is approximately 2%.

In Case VI, the reforming is again restricted to 275-400° F. end point naphtha, and the Fluid cracking operation is also at a 60% conversion level, using natural catalyst instead of synthetic. The cycle oil is thermally cracked for maximum yield of gasoline on crude. In this case the lower butane-butylene production, containing a high percentage of olefins, resulting from the use of natural catalyst, results in a minimum discard of C_4 to fuel and a high gasoline make of 50.7% on crude with a total light oil yield of 75.7%.

TABLE 3—Composition and Octane Characteristics of Blended Gasolines

	Case I 300-400 Naphtha Reform Bbls.	Case II 200-400 Naphtha Reform Bbls.	Case III Naphtha Polyform Bbls.	Case IV TCC Natural Catalyst Bbls.	Case V Fluid Synthetic Catalyst Bbls.	Case VI Fluid Natural Catalyst Bbls.
Straight Run low E.P.	1,100	550	650	900	1,000	1,000
Reform (C_5—400)	250	612	....	374	306	306
Polyform 10#—400 E.P.	....	....	704	....	....	....
TCC Catalytic (C_5—400 E.P.)	....	....	....	660	....	....
Fluid Catalytic (C_5—400 E.P.)	....	....	....	....	627	787
Thermal (C_5—400 E.P.)	756	755	755	200	212	227
Catalytic Polymer	53	82	....	108	185	143
B-B	72	66	22	53	63	83
Total Raw Gasoline	2,231	2,065	2,131	2,295	2,393	2,546
Treated 10# R.V.P. Gasoline	2,220	2,055	2,120	2,284	2,381	2,533
% Yield on Crude	44.4	41.1	42.4	45.7	47.6	50.7
Octanes						
Motor Method clear	65.8	71.8	70.8	72.7	73.0	72.3
Motor Method 3cc TEL	80.7	83.0	82.0	84.5	84.5	84.4
Research Method clear	70.0	78.2	77.1	79.3	79.4	78.6
Research Method 3cc TEL	85.0	89.7	88.5	90.9	90.9	90.6
Weighted Average Octanes*						
cc TEL to 84.7 R.M.	2.8	0.85	1.2	0.6	0.6	0.7
Equivalent M.M.	80.4	78.0	78.0	78.0	78.0	78.3
Sensitivity	4.3	6.7	6.7	6.7	6.7	6.4

*Based on 35% Premium of 80 M.M.—88 R.M.
65% Regular of 77 M.M.—83 R.M.

Cost Review

Although the above yield comparisons indicate a rather large increase of gasoline yield and octane by resorting to more intensive refining methods, this can not be accomplished except at increased cost. In Table 4 the average operating costs of thermal cracking are compared with corresponding costs of the cat-

TABLE 4—Comparison of Average Calendar Day Costs of Various Types of Cracked Units Including Gas Recovery and Gasoline Stabilization

	Unit Cost	Thermal Units Per Cal. Day	Thermal Dollars Per Cal. Day	Fluid Units Per Cal. Day	Fluid Dollars Per Cal. Day	Thermofor Units Per Cal. Day	Thermofor Dollars Per Cal. Day	Houdry Units Per Cal. Day	Houdry Dollars Per Cal. Day
Operating Labor (Man Hrs.)									
Direct Supervision	....	....	24	....	49	....	49	....	60
Direct Labor	....	118	221	196	367	178	330	236	437
Indirect Supervision	....	....	8	....	15	....	12	....	15
Indirect Labor	....	....	40	....	62	....	63	....	68
Total	....	....	293	....	493	....	454	....	580
Maintenance Labor (Man Hrs.)									
Supervision	....	....	20	....	39	....	32	....	25
Direct Labor	....	85	150	183	324	162	286	103	182
Total	....	....	170	....	363	....	318	....	207
Utilities									
Steam (M#)	0.56	440	246	1,000	560	780	437	280	157
Power (KWH)	0.009	6,320	57	4,410	40	4,480	43	5,400	49
Water (M gal.)	0.007	3,916	27	13,500	94	10,820	76	18,400	129
Fuel (bbls.)	2.52	295	744	177	446	312	786	237	597
Total	....	....	1,074	....	1,140	....	1,342	....	932
Operating Supplies									
Catalyst—Fluid (#)	0.1456	....	....	2,400	350	....	....	....	....
Catalyst—TCC (#)	0.0479	....	....	....	....	4,000	192	....	....
Catalyst—Houdry (#)	0.2234	....	....	....	....	....	....	436	97
Misc. Supplies	....	....	8	....	47	....	7	....	52
Total	....	....	8	....	397	....	199	....	149
Repair Material	....	....	57	....	117	....	104	....	178
Total Normal Cost	....	....	1,602	....	2,510	....	2,417	....	2,046
Extraordinary Repairs	....	....	....	....	30	....	200	....	575
Total Daily Costs	....	....	1,602	....	2,540	....	2,617	....	2,621

CASE IV—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10 lb RVP Gasoline Yields Based on Thermal Naphtha Reforming plus TCC Catalytic Cracking of Gas Oil with Natural Catalyst Supplemented by Thermal Cracking of Catalytic Cycle Stock

	Crude Topping		Thermal Reforming (265-400)		Thermofor Catalytic 60% Conv.		Thermal Cracking TCC Cycle		Cat. Poly. 85% Conv.	Stab. for R.V.P.	Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	%	B/D	B/D	B/D	%
$=C_3$ to Cat. Poly.	....	...	10	1.8	37	2.5	4	0.7	...	...	....	...
iC_4	....	...	7	1.3	90	6.0	3	0.5	100	20	....	...
$=C_4$	....	...	28	5.1	70	4.7	11	1.9	16	8	....	...
nC_4	....	...	21	3.8	35	2.8	9	1.6	65	25	....	...
Total B-B to Cat. Poly.	....	...	56	10.2	195	13.0	23	4.0	181	53	53	...
Lt. S.R. Gaso.	900	18.0	...	...	...	...	...	...	...	...	900	...
Reform (C_5—400 E.P.)	....	...	374	68.0	...	...	...	...	...	...	374	...
TCC (C_5—400 E.P.)	....	...	...	...	660	44.0	...	...	...	...	660	...
Thermal (C_5—400 E.P.)	....	...	...	...	...	...	200	33.3	...	...	200	...
Poly Gasoline	....	...	...	...	...	...	...	...	108	...	108	...
Total Raw Gaso.	....	...	...	...	...	...	...	...	...	...	2295	...
Treated Gaso.	....	...	...	...	...	...	...	...	...	...	2284	45.7
Naphtha to Reform	550	11.0	...	...	...	...	...	...	...	...	....	...
Kerosine	500	10.0	...	...	...	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	...	...	...	750	15.0
Total light oil yield	....	...	...	...	...	...	...	...	...	...	3534	70.7
Cat. Cycle to Thermal	....	...	...	...	600	40.0	...	...	...	...	....	...
Red. Crude to TCC	(2250	45.0)	...	...	...	...	...	...	...	...	....	...
Gas Oil to Reactor	1500	30.0	...	...	...	...	...	...	...	...	....	...
Reduced Crude Btms.	750	15.0	...	...	...	...	...	...	...	...	....	...
Thermal Tar	....	...	44	8.0	...	...	344	57.2	...	...	1138	22.7
Gas (F.O.E.)	25	0.5	55	10.0	83	5.5	36	6.0	4	82	285	5.7
Gain (—), Loss (+)	+25	0.5	+11	+2.0	—75	—5.0	—7	—1.2	+32	+46	+43	0.9
Total	5000		550		1500	100.0	600	100.0	325	181	5000	100.0

CASE V—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10 lb RVP Gasoline Yield Based on Thermal Naphtha Reforming plus Fluid Catalytic Cracking of Gas Oil with Synthetic Catalyst Supplemented by Thermal Cracking of Catalytic Cycle Stock

	Crude Topping		Thermal Reforming (275-400)		Fluid Catalytic 60% Conv.		Thermal Cracking Fluid Cycle		Cat. Poly. 85% Conv.	Stab. for R.V.P.	Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	%	B/D	B/D	B/D	%
$=C_3$ to Cat. Poly.	...	...	8	1.8	65	3.7	5	0.7				
iC_4	...	...	6	1.3	124	7.1	3	0.5	133	25		
$=C_4$	...	...	23	5.1	159	9.1	12	1.8	29	12		
nC_4	...	...	17	3.8	35	2.0	10	1.5	62	26		
Total B-B to Cat. Poly.	...	...	46	10.2	318	18.2	25	3.8	224	63	63	
Light S.R. Gaso.	1000	20.0	...	...	...	...	...	...	...	...	1000	
Reform (C_5—400)	...	...	306	68.0	...	...	...	...	...	...	306	
Fluid (C_5—400 E.P.)	...	...	...	...	627	35.8	...	...	...	...	627	
Thermal (C_5—400 E.P.)	...	...	...	...	...	...	212	32.4	...	...	212	
Polymer	...	...	...	...	...	...	...	...	185	...	185	
Total Raw Gaso.	...	...	...	...	...	...	...	...	...	...	2393	
Treated Gaso.	...	...	...	...	...	...	...	...	...	...	2381	47.6
Naphtha to Reform	450	9.0	...	...								
Kerosine	500	10.0	...	...	...	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	...	...	...	750	15.0
Total light oil yield	...	...	...	...	...	...	...	...	...	...	3631	72.6
Cat. Cycle to Thermal	...	...	...	...	653	37.3	...	...	...	...	...	...
Red. Crude to Vac. Still	(2250	45.0)	...	...	...	...	...	...	...	...	...	...
Vac. G.O. to Fluid	1750	35.0	...	...								
Vac. Btms. to Fuel	500	10.0	...	...	...	...	...	...	...	...	...	...
Tar to Fuel	...	...	36	8.0	47	2.7	383	58.7	...	..	966	19.3
Gas (F.O.E.)	25	0.5	45	10.0	142	8.1	36	5.6	7	103	358	7.2
Gain (—), Loss (+)	+25	+0.5	9	+2.0	—102	—5.8	—8	—1.2	+51	+58	+45	0.9
Total	5000	100.0	450	100.0	1750	100.0	653	100.0	467	224	5000	100.0

CASE V1—5000 b/d Crude Run for Normal Kerosine and Diesel Yields. 10 lb RVP Gasoline Yields Based on Thermal Naphtha Reforming plus Fluid Catalytic Cracking of Gas Oil with Natural Catalyst (Filtrol) Supplemented by Thermal Cracking of Catalytic Cycle Stock

	Crude Topping		Thermal Reforming (275-400)		Fluid Catalytic 60% Conv.		Thermal Cracking Fluid Cycle		Cat. Poly. 85% Conv.	Stab. for R.V.P.	Finished Yields	
	B/D	%	B/D	%	B/D	%	B/D	%	B/D	B/D	B/D	%
$=C_3$ to Cat. Poly.	...	...	8	1.8	70	4.0	5	0.7				
iC_4	...	...	6	1.3	55	3.2	3	0.5	64	39		
$=C_4$	...	...	23	5.1	95	5.4	13	1.8	20	12		
nC_4	...	...	17	3.8	25	1.4	10	1.5	52	32		
Total B-B to Cat. Poly.	...	...	46	10.2	175	10.0	26	3.8	136	83	83	
Lt. S.R. Gaso.	1000	20.0	...	...	...	...	...	...	...	...	1000	
Reform (C_5—400 E.P.)	...	...	306	68.0	...	...	...	...	...	...	306	
Fluid (C_5—400 E.P.)	...	...	...	...	787	45.0	...	...	...	...	787	
Thermal (C_5—400 E.P.)	...	...	...	...	...	...	227	32.4	...	...	227	
Polymer	...	...	...	...	...	...	...	...	143	...	143	
Total Raw Gaso.	...	...	...	...	...	...	...	...	...	...	2546	
Treated Gaso.	...	...	...	...	...	...	...	...	...	...	2533	50.7
Naphtha to Reform	450	9.0	...	...	...	...	...	...	...	...	...	...
Kerosine	500	10.0	...	...	...	...	...	...	...	...	500	10.0
Diesel	750	15.0	...	...	...	...	...	...	...	...	750	15.0
Total light oil yield	...	...	...	...	...	...	...	...	...	...	3783	75.7
Cat. Cycle to Thermal	...	...	...	...	700	40.0	...	...	...	...	...	...
Red. Crude to Vac. Still	(2250	45.0)	...	...	...	...	...	...	...	...	...	...
Vac. G.O. to Fluid	1750	35.0	...	...	...	...	...	...	...	...	...	...
Vac. Btms. to Fuel	500	10.0	...	...	...	...	...	...	...	...	...	...
Tar to Fuel	...	...	36	8.0	...	...	411	58.7	...	..	947	18.9
Gas (F.O.E.)	25	0.5	45	10.0	105	6.0	39	5.6	7	34	255	5.1
Gain (—), Loss (+)	+25	+0.5	9	+2.0	—87	—5.0	—8	—1.2	+44	+19	+15	0.3
Total	5000	100.0	450	100.0	1750	100.0	700	100.0	330	136	5000	100.0

alytic cracking units operated by the Sinclair Refining Co. These operating costs are based on units which have a charge capacity of approximately 10,000 b/s/d of feed stock, and represent the average costs for the past four years adjusted to current labor rates and equivalent utility unit costs.

As noted, the cost of operating a thermal still is considerably lower than that of any of the catalytic cracking units. These increased costs for catalytic cracking are mainly in the operating labor, maintenance labor and operating supplies items, the largest additional charge being the cost of the catalyst. The normal operating costs favor the Houdry process. However, the total operating costs, including extraordinary repairs, are about a stand-off with a slightly lower cost in favor of the Fluid unit.

The extraordinary repairs on the Thermofor unit include extensive repairs to the kiln and conversion of both the reactor and kiln to the solid bed design. This item should decrease materially since future extensive repairs on the kiln are not anticipated. The high extraordinary costs in the Houdry unit data represent the cost of catalyst changes and case repairs which occur at two year intervals. Re-tubing of the catalytic cases now contemplated will incorporate the latest design which will simplify catalyst changes and thereby reduce future maintenance costs.

Conclusion

In conclusion, it must be emphasized that the data presented, with the exception of Polyforming, are predicated on Sinclair-type of operation. They may differ materially when charging other types of crudes. The thermal cracking operations have been conducted to produce an approximate 12 gravity fuel in all cases. If sufficient thermal cracking capacity is available, the fuel gravity can readily be adjusted to a 10 gravity basis with corresponding increase in gasoline yields, but also at an increase in cost.

The supplementary thermal cracking of the catalytic cycle oils is based on the assumption that the catalytic unit is an addition to the refinery facilities and that the thermal equipment previously used for cracking the virgin oils will be available. In the northern section of the country the sale of catalytic cycle oil in blend with straight-run distillates might alter the operation of the catalytic unit in favor of somewhat higher conversions to maintain gasoline production without the supplementary thermal cracking of catalytic cycle stock. This in turn would require increased coke burning capacity and hence a larger catalytic unit. The increased gas make and greater discard of C_4's to fuel at the higher conversion level would require realization of higher value for these products either in sales to utility companies or to the liquefied gas market in order to obtain a favorable return.

The higher liquid recovery from the Thermofor catalytic cracking unit results in a better yield of useful products on the material charged to the reactor. Our present limitation to the use of completely vaporized feed to the up-flow reactor prevents flashing the reduced crude to a low per cent bottoms on crude and thus restricts the quantity of feed stock available for catalytic cracking. However, further development of down-flow liquid reactor feed technique can readily change the Thermofor yields to a more favorable basis. The use of new type catalyst, such as silica magnesia, which minimizes B-B production would also reduce the discard of C_4 fractions to fuel and thereby improve gasoline yields.

The Fluid operating costs presented do not include feed preparation, which is an integrated part of the Thermofor process, and, therefore, additional costs for preparing the heavier feed stock to the Fluid must be considered. On the other hand, the Fluid costs presented include a considerable amount of operation on re-treat during the war period which in turn results in an average higher steam consumption than is normally encountered when processing heavy charging stock for motor gasoline.

Although Houdry unit operating costs have been presented for comparison, the lack of any Sinclair data on the operation of this unit on heavier oils has precluded any comparison of yields. Anticipated yields from the Houdry unit would be similar to those of the Thermofor unit and would show a high per cent liquid recovery on charge with a corresponding high yield of isobutane. Unless alkylation were used for processing the light fractions, the discard of isobutane to fuel would be excessive.

Sufficient details of costs and yields have been included to permit a refiner to substitute other values and thus derive an operation best fitted for the case under consideration.

It has been shown that so-called normal reforming of 300-400° F. naphtha with good thermal operation on the heavier crude fractions results in a fair yield of gasoline on crude and the lowest operating costs. As long as the Mid-Continent area is in short supply, gasolines of lower octane standard may be acceptable. If com-

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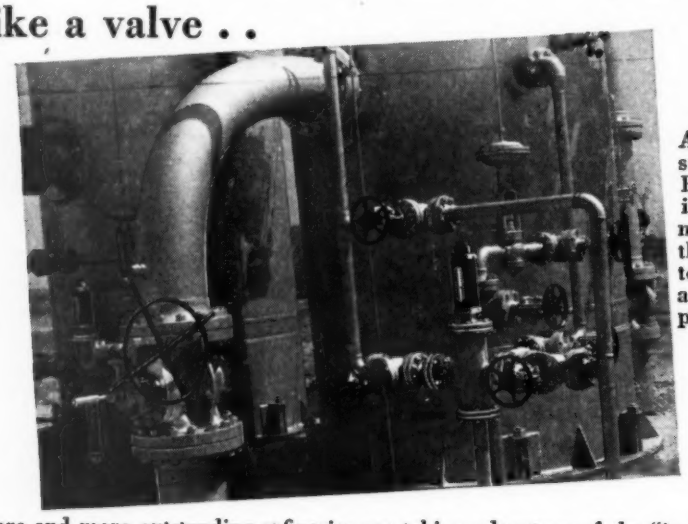

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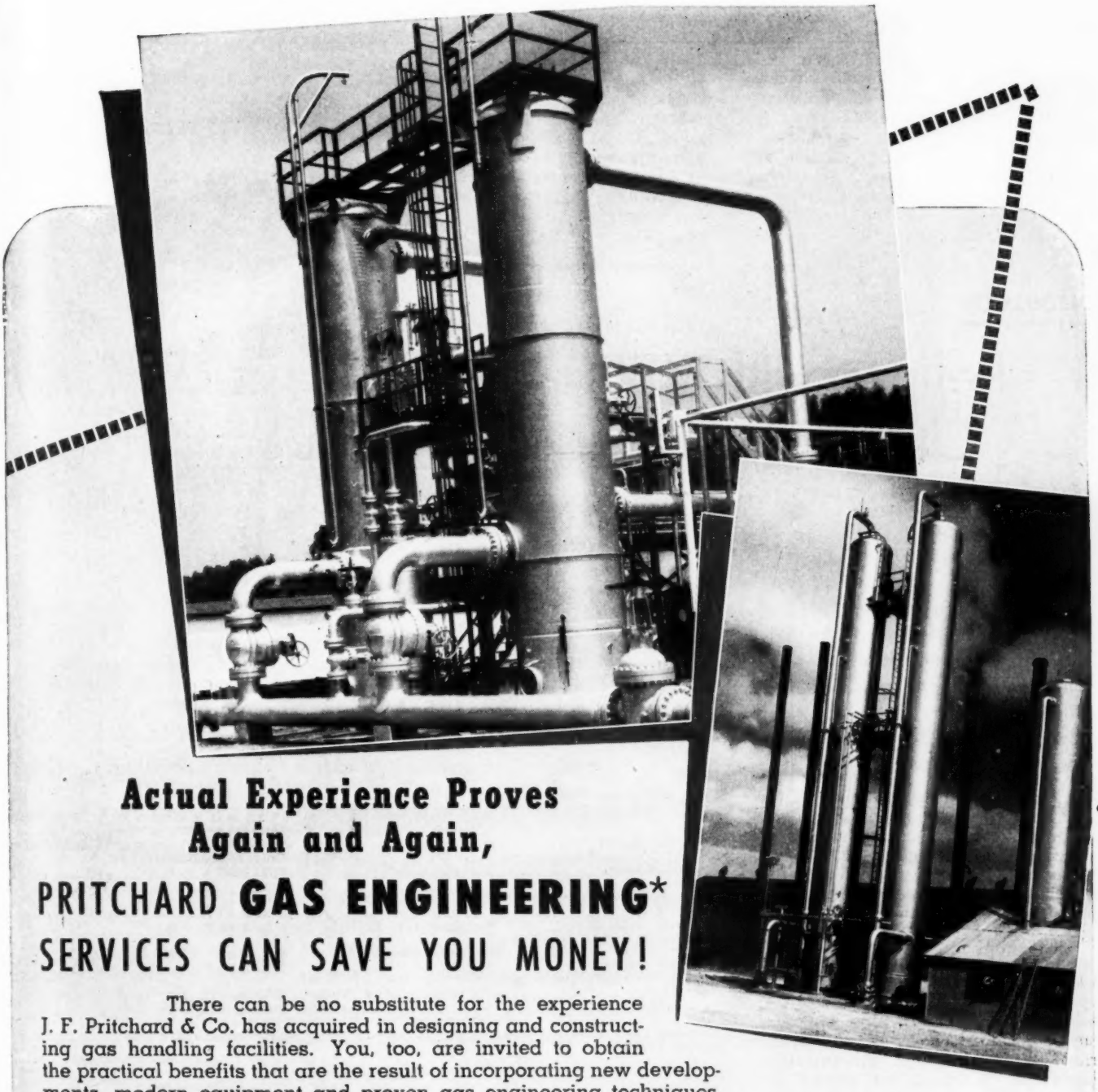

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petition, due to installation of catalytic cracking and allied processes, demands higher octane standards in this area, a refiner can resort to rerun of the straight-run gasoline to produce a low end point, high-octane product and, by reforming or preferably Polyforming the total 200-400° F. naphtha, meet the competitive higher octane standards at some sacrifice in yield.

However, the improved gasoline yields and high octanes resulting from installation of catalytic cracking processes are real and represent a conservation of petroleum resources at a sacrifice of heavy fuel production. The practicability of installation of catalytic cracking in the small refinery appears to depend largely on the construction cost of a small unit. Therefore, a simplified and hence cheaper unit, even at a sacrifice in the flexibility now built into the larger catalytic units, seems to be the proper approach for the design engineer.

DISCUSSION

Refiner with 4500 B/D "Cat Cracker" Cites Advantages in His Operation

By JOHN S. PFARR
Vice President, Leonard Refineries Inc., Alma Mich.

Prepared discussion given at the 13th Mid-Year Meeting of the API Division of Refining following presentation of the paper entitled "Refinery Tools for Producing High Octane Gasoline."

WE ARE a living example of the small refiner that bought catalytic cracking, and are finding, as we expected, that this method of refining is less expensive per barrel of charge for us than was our thermal cracking operation.

An explanation, of course, is in order for such a statement, which varies so much from the accepted opinion. We had a Dubbs two-coil selective thermal cracking unit designed for 1100 bbl. of reduced crude raw oil charge with fractionation equipment designed for future reforming capacity of 1000 b/d. Parts of the thermal cracking unit were used in converting to a TCC catalytic cracking unit which was designed for a reduced crude raw oil charge to the feed preparation furnaces of 4500 b/d. Actually we find the capacity close to 6000 b/d. This was possible since our thermal unit was designed for a relative high recycle ratio while our catalytic unit was designed for either once-through or a moderate amount of recycle stock. Sizes of the converted vessels are given in Table 1.

To give briefly a few details of our experience connected with the feasibility of owning catalytic cracking, we can state the following.

Our 1500 b/d thermal cracking unit was manned by two men per shift. Our 4500 b/d catalytic unit is manned by three men per shift, with a decrease in complaints concerning "over-work". As nearly as we can estimate, required supervision on the two units are about equal. Detailed cost data for 11 months' operations are presented in Table 2.

We have always considered it necessary to maintain an equal or superior quality product from a competitive marketing standpoint. To do that we had to gradually step up our thermal reforming operations to the very uneconomical severity of 65% liquid

TABLE 1—Size of Major Equipment Used in Conversion

Used on Thermal Unit	Use on T.C.C.	Size
Heavy Oil Heater	Feed Preparation and Steam Superheating	98–2⅝ O.D. x ¼-in. x 22 ft. 10 in. Tubes Duty 14,000,000 BTU/hr.
Light Oil Heater	Feed Preparation	98–2⅝ O.D. x ¼-in. x 22 ft. 10 in. Tubes Duty 14,000,000 BTU/hr.
Flash Chamber	Tar Separator	6 ft. 6 in. x 30 ft.
Fractionating and Feed Preparation Column (75 lb)	Fractionating Column (4 lb.)	6 ft. x 60 ft.
Stabilizer (175 lb.)	Stabilizer (175 lb.)	3 ft. x 45 ft. 6 in.
Pressure Distillate Receiver (75 lb.)	Secondary Receiver (75 lb.)	4 ft. 6 in. x 12 ft.
Absorber (70 lb.)	Absorber (70 lb.)	3 ft. x 30 ft.
Pressure Distillate Condenser (75 lb.)	Gas and Gasoline Contact Cooler (75 lb.) Quench Oil Cooler	2500 sq. ft. pipe coil 2500 sq. ft. pipe coil
Absorber Oil Cooler	Tar Sep. Btms. Cooler	2500 sq. ft. pipe coil
Quench Oil Cooler	Absorber Oil Cooler	680 sq. ft. pipe coil

TABLE 2—Comparative Cost Data*

Description	Thermal Unit: Cost Per Cal. Day	Thermal Unit: Cost Per Bbl. Raw Charge	TCC Unit: Cost Per Cal. Day	TCC Unit: Cost Per Bbl. Raw Charge	TCC Unit: Cost Per Bbl. of Virgin Reactor Charge
Operating Labor	$ 69.23	$.056	$ 135.82†	$.033	$.048
Maintenance Labor	62.73	.049	71.62	.018	.025
Fuel Used	179.99	.147	292.38	.072	.104
Chemicals	45.26	.037	118.87‡	.029	.042
Light and Power	29.02	.024	18.85	.005	.007
Water	6.30	.005	15.98	.004	.005
Maintenance Materials	58.93	.048	97.40	.024	.034
Depreciation	49.04	.040	239.09	.058	.085
Royalties	40.19	.033	139.85	.034	.050
Taxes and Insurance	14.75	.012	36.08	.009	.013
Service Departments§	361.72	.295	408.64	.100	.145**
Total	$917.16	$.746	$1574.58	$.386	$.558

* These data are based on the same period of operation as used in Table 3.

† This includes all catalyst handling, both new and spent. Also reflects labor rate increases since 1945.

‡ Chemicals include catalyst expense.
Catalyst Consumption.
Average tons per month 26.00
Lbs. per bbl. total reactor charge 0.35
Approximately 80% of catalyst consumed is recovered as fines. These fines can be marketed profitably as desulfurization catalyst.

§ Service department includes steam plant, supervision, tank farm, loading rack, laboratories, pumping and miscellaneous plant expense. (Steam is metered. Balance of service department charges are distributed to units on arbitrary pro rated percentage.)

** TCC unit charged for steam used in excess of that produced. Unit is neither given credit for coke produced or charged for steam produced from the coke.

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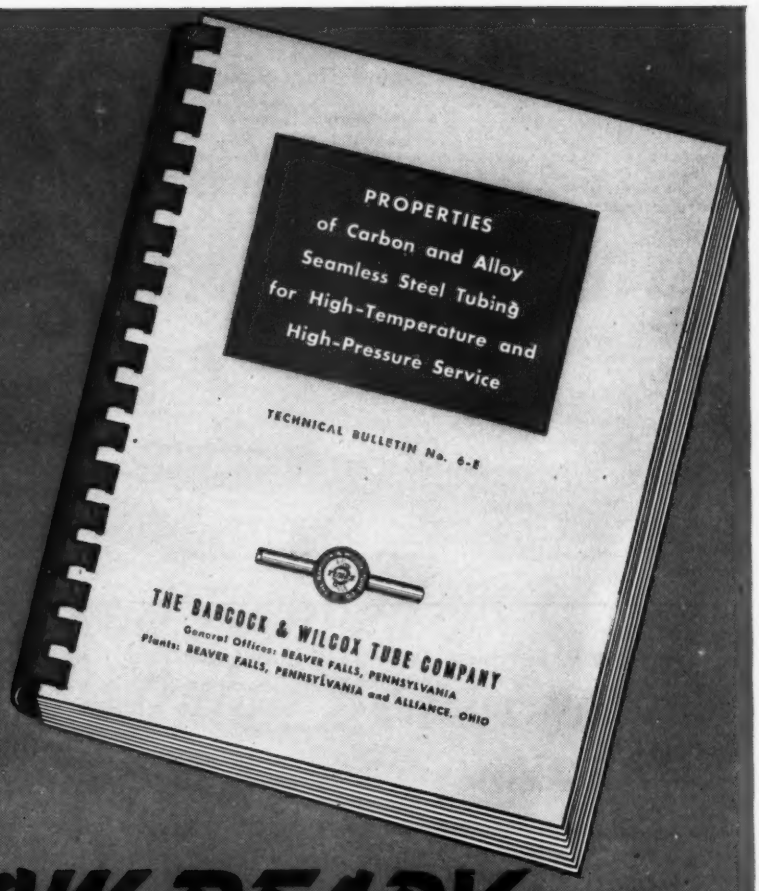

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TABLE 3—Comparative Throughput and Yield Data*

	Thermal Unit		TCC Unit	
Throughput	Average Bbl. Per Cal./Day	Yield Percent	Average Bbl. Per Cal./Day	Yield Percent
Reduced Crude	1227	100.0	4086	....
Tar Separator Btms.	....	....	1267	....
Virgin Reactor Charge	....	....	2819	100.0
Yield				
Catalytic Gasoline	....	....	1347	47.8
Cracked Gasoline	594	48.4	....	....
Syn. Tower Bottoms	....	....	388	13.8
Cracked Residuum	480	39.1	....	....
Butane	....	....	105	3.7
Propane†	....	....	17	.6
Gas F. O. E.‡	121	9.8	266	9.4
TCC Distillate	....	....	747	26.5
Codimer§	8	.7	....	....
Reboiler Oil	24	2.0	....	....
Total	1227	100.0	2870	101.8**

* Thermal unit data based on actual operations for an 11-month period ending Feb. 28, 1946. TCC unit data based on actual operations for 11-month period ending March 31, 1948.
† No propane was credited to this unit prior to October, 1947.
‡ For thermal unit gas and loss or gain set to yield 100%.
§ Codimer operation discontinued August 1, 1945.
** Coke of approximately 5% by weight of charge not included.

TABLE 4—Typical Daily TCC Throughput and Yield Data With Varying Conditions

	High Recycle		Once Through	
Throughput	Bbls.	%	Bbls.	%
Raw Charge	2729		6616	
Tar Separator Btms.	566		1644	
Virgin Reactor Charge	2163	100.00	4972	100.00
Recycle TCC Distillate	2367		....	
Total Reactor Charge	4530		4972	
Yield				
Gasoline	1258	58.15	2195	44.14
Butane	150	6.93	99	2.00
Syn. Tower Btms.	189	8.73	1098	22.76
TCC Distillate	314	14.49	1297	26.08
Gas F.O.E.	295	13.63	293	5.89
Propane	....	....	20	.40
Total	2206	101.93*	5002	101.27*

*Coke yield not included.

recovery. Catalytic cracking permits us to maintain even higher quality and at the same time we have reduced the severity of reforming so that we obtain an average of over 90% liquid recovery.

A small refiner needs maximum flexibility. For example, our TCC unit can assimilate a very wide diet. We have, on occasion, charged straight crude oil of the Michigan Deep River type. This gave us catalytic cracking of the kerosine and heavier fractions and almost a complete desulfurization of the straight-run gasoline.

We buy slop oils from paper companies after they have removed certain desirable waxes used in their processes.

We buy overhead products from vacuum towers where asphalts are manufactured.

We are constantly purchasing No. 5 fuel oil where such oils are the end products of topping plants.

All of these and other miscellaneous stocks have caused no hardships from the standpoint of either operation or quality. You who are familiar with thermal cracking units know that heterogeneous charge stocks bring headaches and short runs.

In addition, we have recently installed liquid injection whereby we can add up to 600 b/d of material above 1000 e.p. We cannot report at this time concerning the economics of this plan, but it shows great promise and it certainly adds flexibility.

TABLE 5—Average Utility Balance TCC Unit Studied and Metered During September, 1947

Electricity, KWH	
Elevator	20.0
Flue Gas Compressor, Instrument Air Compressor and Miscellaneous	37.7
Total to Plant	57.7
Water, GPM	
Boiler Water to Kiln	39
Cooling Water	
Barometric Condenser	1,100†
Contact Cooler	235
Other Coolers	340
Total Cooling Water	1,675
Fuel Gas, cu. ft./hr.	
To Heaters	22,500
To Airline Burner	3,150
To Wet Gas Compressors	1,300
Total Fuel Gas	26,950
Steam, Lbs./hr.	
Superheated (125 lb.)	
Tar Separator Inlet	2,550
Tar Separator Overhead	1,300
Purge	2,000
Total	5,850
290 lb. Steam	
To Airline Blower	4,500
To Water Circulating Pump	1,600
Total	6,100
125 lb. Steam	
To Pump House	6,900
Reactor Seal	1,500
Circulating Quench Pump	1,200
Water Make-up Pump	760
To Tar, Light & Hy. Gas Oil Pumps	4,000
To Side Stripper	280
Total	14,640
Total Steam Consumed, lbs./hr.	26,590
Steam Produced in Kiln (290 lb.), lbs./hr.	14,900
Net Steam Consumed, lbs./hr.	11,690

* Does not include lighting
† Goes to hot boxes for reuse

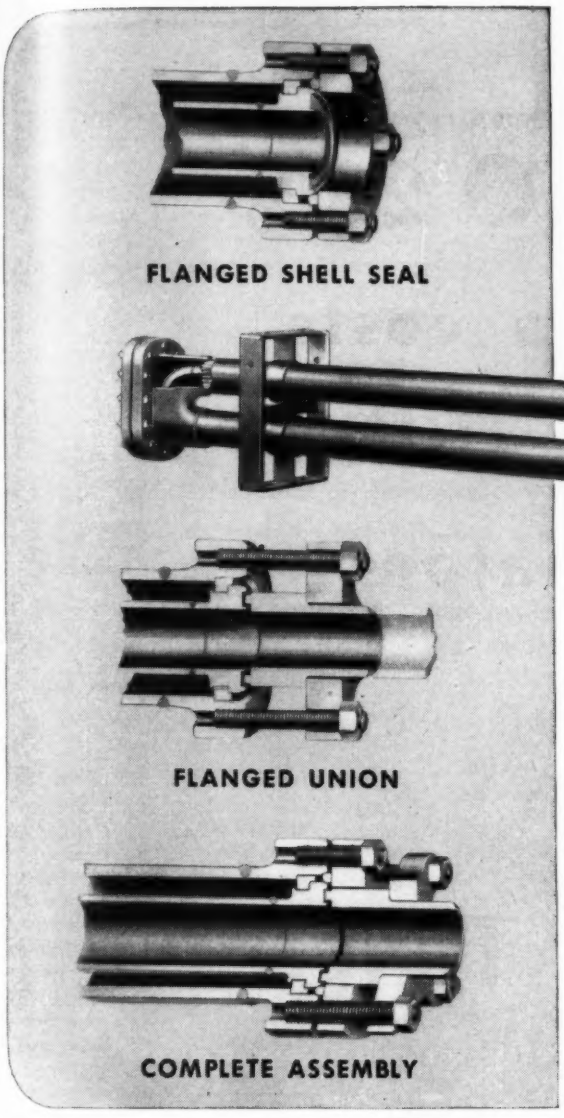
Power and other utility failures are not unknown to the small refiner. Such failures on our unit mean bypassing the reactor and circulating the charge until the trouble is corrected, then back into the reactor and on stream in 30 minutes. With thermal cracking, this would mean a clean-out job.

As to maintenance expense, our first clean-out and inspection data have been published. We recently had our second with even better results. The data collected from the two have shown us that from now on we need to inspect only once a year instead of twice as we had planned. We know now that repair and maintenance labor and materials will be substantially lower per barrel of catalytic cracking than we experienced with our thermal cracking.

This unit cost us our 11-year-old Dubbs plant plus approximately $800,000. While costs have gone up since our unit was started in September, 1946, it is our belief that by the removal of some of the excess capacity from the catalytic section that cannot be practically utilized, any thermal cracking unit in the range of 1500 to 2000-bbl. reduced crude charge can be converted to TCC catalytic cracking with a reduced crude charge of roughly three times the thermal capacity at an approximate price today of $1,000,000.

What are the prospects of paying out that investment? Frankly, under the price set-up that we are operating under at the present time, catalytic cracking is not very profitable. However, on the other hand, were we operating our thermal cracking unit under present market conditions, the thermal process would be showing a sizable loss. Unfortunately, a refiner who is building business on quality cannot turn cracking on and off to match market fluctuations. Consequently, the pay out time now is almost the same as when we made our decision, that is, about two and one-half years, if the losses on the thermal unit are added to the profits of the catalytic unit.

There is no need to go into such economics in detail as each refiner, especially each small refiner, has his individual marketing conditions, his own problems regarding the availability of crude or catalytic charging stock and many other circumstances which make another refiner's data not only not applicable but often quite confusing. We can, however, state our throughputs, our yields, our operating costs and from them each interested refiner can substitute his own figures. These and other pertinent data on our operations are given in Tables 3, 4 and 5.



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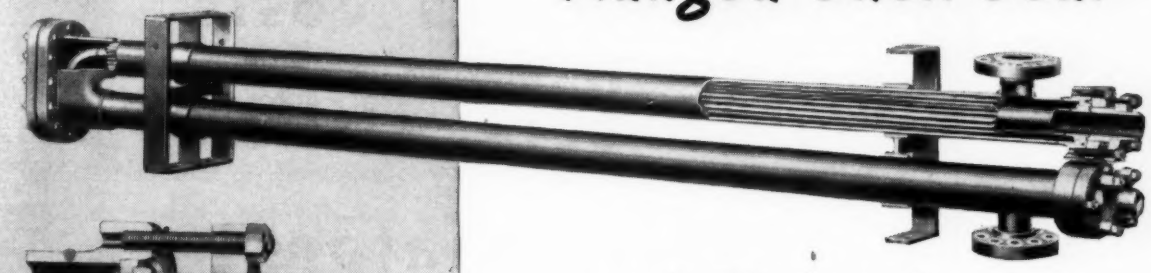

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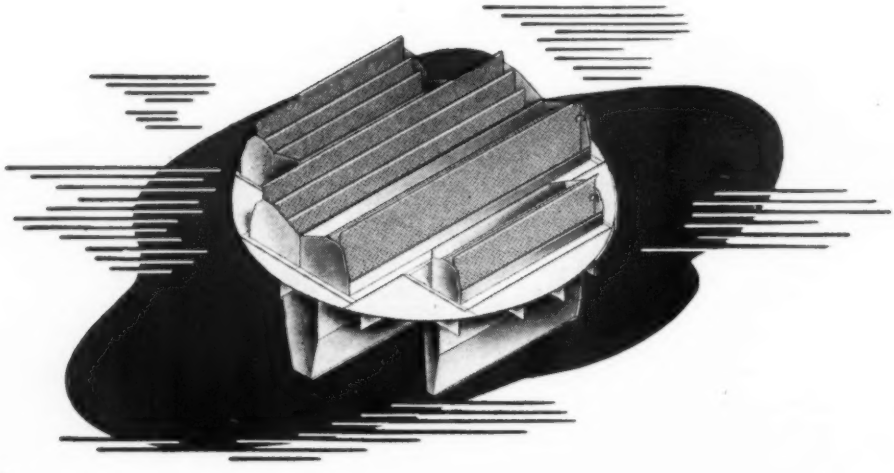

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STEEL DIKES SAVED SIX ACRES

By FRED L. PLUMMER
Director of Engineering, Hammond Iron Works

A type of steel enclosure for oil storage tanks is described where the steel bottom of the storage tank is extended outward and a second steel shell is erected to form a moat having a capacity equalling that of the enclosed tank. This type of construction also prevents escape of liquids into the ground underneath the shell. The ring of steel plates forming the outer wall is supported on a concrete ring foundation. The top of the steel dike is stiffened with an inside wind girder, which in addition serves as a deflector to reduce the possibility of a "boil over" wave. Fire tests in an open top tank are reviewed briefly.

IT is frequently necessary to construct and locate above-ground storage facilities for fuel oils and other petroleum products in high-cost, built-up portions of metropolitan areas. In order to insure the safety of such installations and comply with municipal codes and standards, such as those of the National Board of Fire Underwriters, it is required that all tanks used to store flammable liquids be enclosed by dikes having a storage capacity as great, if not greater, than that of the tank or tanks surrounded by the given dike.

When crude oil is stored in such tanks the N.B.F.U. standards also require that dikes have "suitable" coping or deflector projecting inward, and be so designed and constructed as to minimize the effect of a "boil over" wave. Such a "boil over" wave may result if a mass of hot oil comes into contact with water which might have collected in the bottom of the tank or area enclosed by a dike.

It has been reported by the American Petroleum Institute that when certain oils burn heat is carried down into the oil for some distance to a "heat-wave front" which forms a sharply-defined division between hot and cold oil. The possibility of a serious loss of product due to this effect is much less for a high dike than for a low dike, since the "boil over" wave will not be created until the oil level is within a few feet of the bottom and therefore several feet below the top of a high dike.

When adequate low-cost ground areas are available it will usually be found most economical to space storage tanks far apart and surround them with low earth embankments having a height of 3-5 ft., with a flat section at the top about 3 ft. wide and side slopes consistent with the natural slope of the material used for the construction of the dike. Dikes of this type can be constructed economically with modern earth moving equipment.

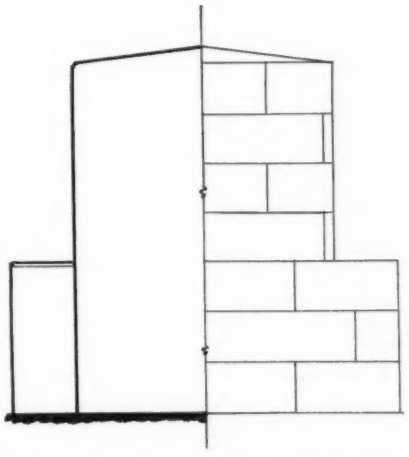

Fig. 1—Steel dike with steel floor to prevent escape of product by ground seepage

When the cost of ground areas is high or if it is necessary to locate tanks on ground having a steep slope, the use of steel or reinforced concrete walls results in a safe and economical installation. Such walls should be located far enough from the shell of the tank so that the scouring action of the winds will prevent the accumulation of combustible vapors within the dike. Since concrete is not normally assumed to resist tension forces, the required area of reinforcing steel in a circular concrete ring wall subjected to hydrostatic loading is essentially the same as that required for a steel plate ring wall. The concrete serves to hold the reinforcing bars in place and to protect them from corrosion and heat.

Under current conditions the excessive cost of material for forms added to the high field labor costs for constructing the forms and placing the reinforcing steel results in overall costs for a reinforced concrete wall which are considerably higher than for an equivalent steel wall with adequate foundation. The use of dikes of rectangular shape or of other shapes requiring straight wall segments will usually result in higher costs whenever steel or reinforced concrete walls are used, since such walls and their foundations must be designed to act as cantilever retaining walls subjected to bending forces rather than ring elements which resist the liquid pressures by uniform tension stresses in a much more efficient manner.

Fig. 1 shows a type of construction used by one major oil company for storage facilities in areas where it is essential that none of the stored product be allowed to escape, even by seepage through the ground. The steel bottom of the storage tank is extended outward and a second steel shell is erected, forming a steel moat or open top tank having a capacity equal to or greater than that of the closed tank. The additional cost of a steel bottom for the moat is usually not justified. Most steel dikes consist of cylindrical steel shells attached to ring foundations of concrete of sufficient depth to prevent the escape of liquid underneath the steel shell.

The Hammond Iron Works recently completed a typical installation of this type for the Coastal Oil Co. at their Port Newark N. J., terminal. Local conditions precluded the use of low earth dikes and comparative cost estimates demonstrated the economy of using steel walls rather than walls of reinforced concrete. The installation included three new storage tanks of 96,000 bbls. capacity each, with a diameter of 120 ft. and 48 ft. high. Each tank was surrounded by a steel dike wall 24 ft. high having a diameter of 172 ft.

Fig. 2 shows an early construction view. The concrete foundation ring for one of the steel dike walls is shown in the foreground, with part of the first ring of steel plates in position. These plates as well as those in the storage tank are 8 ft. wide and butt welded. The plates are supported on small bearing plates

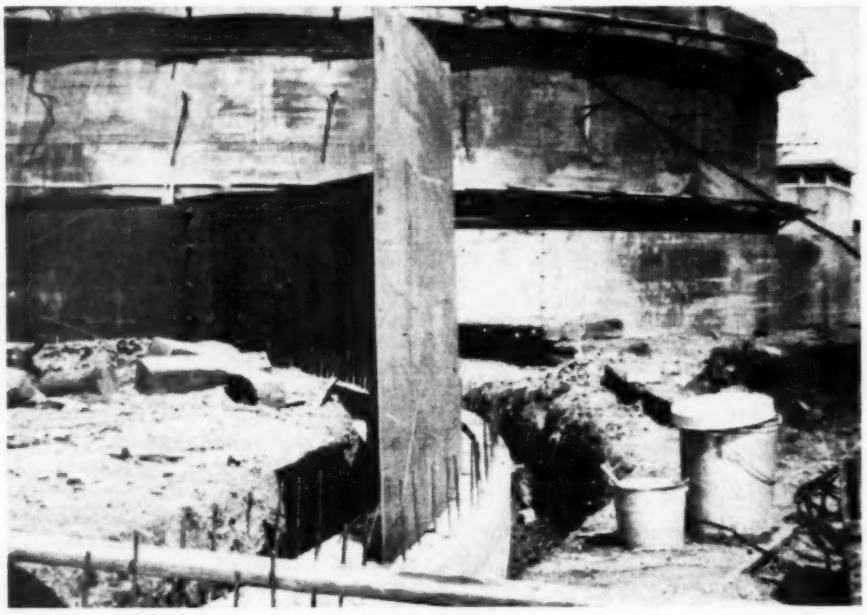

Fig. 2—Steel dike under construction showing concrete foundation with part of the first ring of steel in position

spaced on 4 ft. centers in the center groove at the top of the concrete ring. After the steel dike wall was erected and welded, the reinforcing bars shown extended above the concrete ring in Fig. 2 were bent over and welded to the steel wall.

Concrete was then added to embed these bars. The height of the foundation above the top of the bars was raised with a mastic fill placed adjacent to both sides of the steel wall at its junction with the concrete. In the background of Fig. 2 may be seen the first ring of the steel dike wall for a second tank of which the first four rings have been assembled ready for welding. Two rings of scaffold planks and brackets for a third ring on this tank may be noted in this picture.

The top of the steel dike wall is stiffened with an inside wind girder which also serves as a deflector which materially reduces the possibility of a "boil over" wave. This girder is wide enough to serve as an emergency walkway around the top of the steel dike wall.

For this installation, earth dikes of the conventional type would have required a ground area of perhaps 8 or more acres, equal to about 4 times the area occupied by the actual installation.

The design of steel dikes of the type just described may be based on the rules given in API Standard 12-C for All-Welded Oil Storage Tanks. These rules do not at present cover open top tanks but will probably soon be revised to cover such construction. The formula given in the AWWA Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs, covering the required action modulus for top girders of open top tanks may be used to determine the size of this member.

Since the circular walls of such dikes are not normally subjected to any bursting stresses and can only be subjected to such forces if the enclosed tank fails completely and releases the full amount of the stored product, it would seem logical to use somewhat higher working stresses when determining the required thickness of the shell plates. The API Code specifies for design purposes a base stress of 21,000 psi. a joint efficiency of 85% for butt welded joints and a liquid weight of 62.4 lbs. per cu. ft. In a tank so designed and used to store oil with a specific gravity of 0.8, the maximum bursting stress in the shell plates would not exceed 14,280 psi.

The inside of such tanks is not usually painted nor can it be easily inspected. Both sides of the steel shell forming a dike should be kept painted and can be easily inspected at any time. The use of a stress of 18,360 psi. corresponding to the value noted above should result in a structure of adequate safety and reasonable economy. This actual working stress would call for the use for design purposes of a base stress of 27,000 psi., a joint efficiency of 85% for butt welded joints and a liquid weight of 62.4 lbs. per cu. ft.

If as the result of a major failure, a steel dike is filled or partially filled with burning oil or gasoline, relatively high temperatures may be created in the steel plate. Tests were made by the U. S. Naval Research Bureau at the Findlay, O. tank farm of the Standard Oil Co. (Ohio) during July, 1945. These tests were made in an open top tank 93 ft. in diameter and 28 ft. high. Two feet of product consisting of 30% light ends (gasoline cut) of an Illinois crude oil floating on water so that the top of the oil was 14 ft. below the top of the tank, was used. Temperatures of the steel shell, observed after a short pre-burn period, included the following: 338° F., 530° F. and 1050° F. at points 3 in., 2 in. and 1 in. respectively below the surface of the oil; 1210° F. at the oil surface and 1440° F. at a point 1 in. above the surface of the oil. Higher temperatures were observed at points nearer the top of the shell, the maximum observed temperature being 2400° F. at a point about 8 ft. above the surface of the oil.

The tensile strength of steel increases to a maximum value from 10 to 15% higher than that at normal atmospheric temperatures as the temperature of the steel rises to about 500° F. At higher temperatures the tensile strength of the steel decreases. At 1600° F. the tensile strength will normally not equal more than 20% of the corresponding value at atmospheric temperatures. In the rolling mills such steels are normally heated to temperatures in excess of 2000° F. for rolling operations.

Since there are no significant tensile or compression stresses in the steel shell above the liquid level or at points a few inches below this level, it is evident that the temperatures resulting from the burning of product retained within a steel dike will not reduce its ability to safely resist the bursting stresses created by the pressure of the stored liquid.

Damage to storage tanks which have gone through fires without an explosion has usually been limited to collapse of the roof, sometimes pulling the top of the tank shell in and down, when the roof columns were weakened to the point where they could no longer safely support the roof load. The writer has observed fire tests in a shallow open tank which was used repeatedly without showing any evidence of damage or severe distortion.

For a deep open top tank, it seems probable that a fire of long duration might cause considerable buckling of the steel plates above the liquid level due to the expansion and contraction resulting from the sharp temperature gradients. However such distortions would not affect the safety of the installation and might be such that filling the tank with water would restore the shell to its original cylindrical form.

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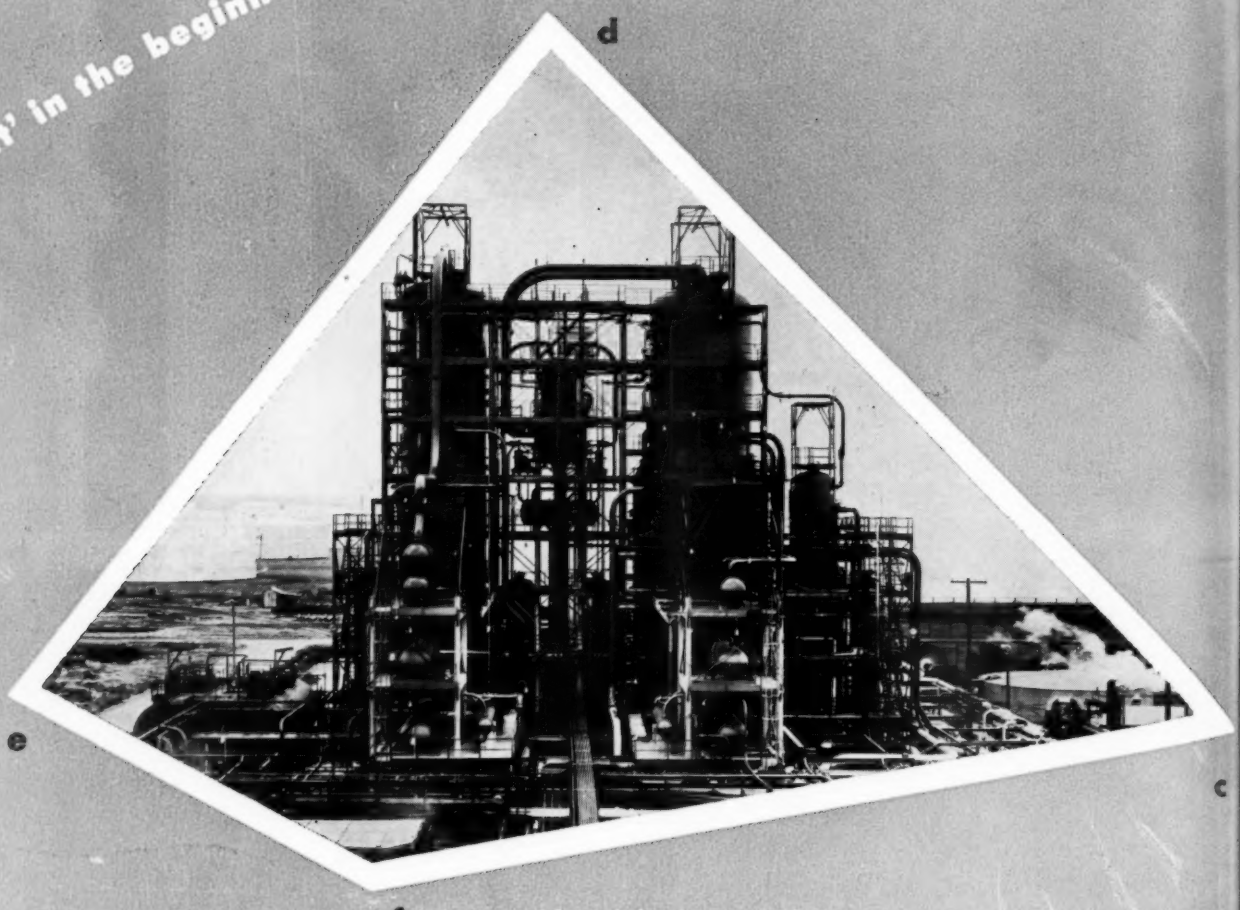

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LABORATORY METHOD

Polarographic Determination of Naphthalenes In Kerosine and Light Gas Oils

By D. P. THORNTON, JR.

Assistant Editor, Petroleum Processing

The evident importance of naphthalene as a raw material in the synthesis of compounds such as phthalic anhydride, for example, have indicated the need for a simple routine method for the determination of naphthalenes in petroleum fractions. A procedure using the polarograph is based on the reduction of condensed ring bicyclic hydrocarbons at high negative potentials.

A RAPID analytical method for the determination of naphthalenes in kerosine and light gas oils has been developed, using the polarograph with the dropping mercury cathode procedure to detect concentrations in the neighborhood of one one-hundredth of a milligram (10^{-6}g.) in 10 cc. of sample containing less than 0.5 cc. of kerosine. As little as 3 cc. of sample may be used. Time required for the actual analysis, excluding preparation of solvents and apparatus, is from 20 to 30 minutes. Monocyclic aromatics, paraffins, naphthenes and mono-olefins do not interfere.

The method has been reported by Burdett and Gordon,* Shell Oil Co., Wood River, Ill., using a Model XX Recording Polarograph manufactured by E. H. Sargent & Co., Chicago. It involves reduction of the naphthalenes in a dioxane-water medium containing tetra-*n*-butylammonium iodide as a supporting electrolyte.

Briefly, the polarographic dropping mercury cathode method measures the electric current which passes through a solution being electrolyzed, when a mercury layer is used as anode and mercury drops from a glass capillary constitute the cathode. If the solution contains any material which can be reduced electrolytically, such as metallic salts or unsaturated organic compounds which may be further hydrogenated, and if the electrodes are polarized by an increasing voltage, then for any cathodic reduction a current equivalent to the amount of material reduced passes through the solution.

A typical voltage-current curve is diagramned in Fig. 1, where one substance is electro-reducible in the voltage interval under consideration. In practice, one or more such substances will be present and a "step" for each substance will occur on the curve. It will be noted that the curve, or step, consists of three parts: (1) a gradually increasing curve roughly proportional to voltage, (2) an interval where current increases sharply and then decreases in approximately the same manner and (3) another gradually increasing curve similar in slope to (1).

The current represented in the first part of the curve is principally that necessary to maintain a cathodic charge on the dropping electrode and indicates the absence in the electrolyte solution of reducible ions whose reduction voltage lies within that section. When voltage approaches the reduction potential of the available electro-reducible ion there is a sharp increase in current, practically independent of voltage. This represents the discharge of reducible ions present in the immediate area of the cathode. The last, or roughly horizontal section, represents a current the intensity of which is determined by the diffusion rate of the reducible ion into the vicinity of the cathode and is approximately proportional again to voltage applied.

Diffusion current in the steep portion of the curve is a measure of the concentration of reducible ions present. The inflection point located in this portion of the curve is the reduction or "half wave" potential of that ion under the particular conditions established. It is qualitatively characteristic for the substance under examination. Another method of expressing this voltage, which also will be found in the literature, is known as the "tangent potential;" this tangent angle must be expressed for a stated corresponding concentration.

A discussion of procedures for determining half wave and tangent potentials, and instrument procedure for taking polarographs is outside

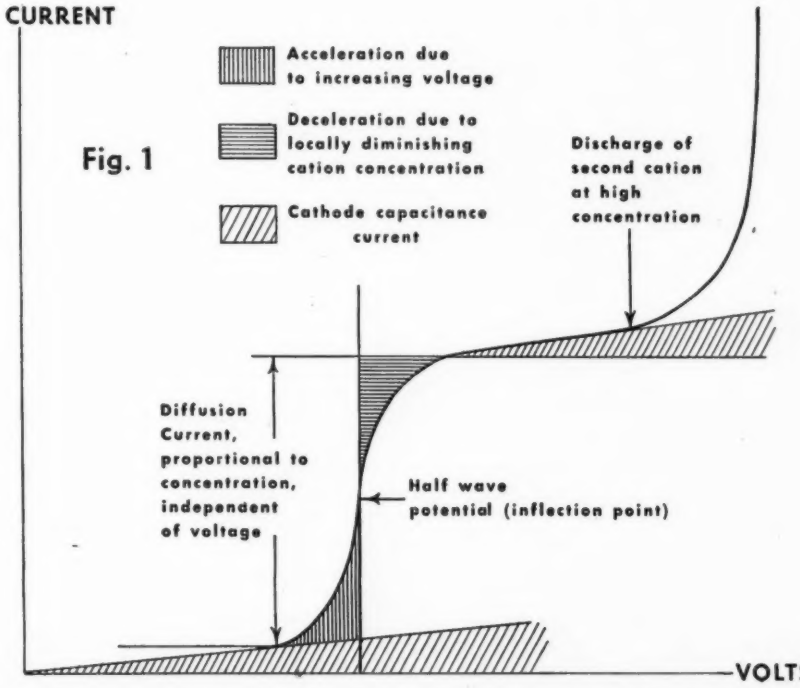

CURRENT
Fig. 1
Acceleration due to increasing voltage
Deceleration due to locally diminishing cation concentration
Cathode capacitance current
Discharge of second cation at high concentration
Diffusion Current, proportional to concentration, independent of voltage
Half wave potential (inflection point)
VOLTS

Fig. 1—Schematic diagram of a typical polarograph curve showing "step" produced during the determination of one elctro-reducible substance

* Burdett, R. A., and Gordon, B. E., "Polarographic Determination of Naphthalenes in Petroleum Fractions," *J. Am. Chem. Soc.* 19, No. 11, September, 1947.

the scope of this article, however, and the interested reader is referred to the literature and makers of scientific instruments. Likewise, a description of the various commercial instruments is not treated.

The literature reports that a very sensitive galvanometer will reveal traces of electro-reducible substance down to 10^{-6} gram molecules per liter. Commercial equipment is available which automatically plots the voltage-current curve as the analysis proceeds, the inherent limit of instrumental accuracy being reported for one type as plus or minus 12.5 microvolts or 0.5% of current measured.

Method of Analysis

Petroleum fractions as such cannot be used in the instrument due to their extremely poor conductivity. It is therefore necessary to use a solvent having a satisfactory conductivity and good solubility for the desired materials. Although there undoubtedly are other good polarographic solvents more easily purified than dioxane, it was chosen primarily by Burdett and Gordon because of its excellent solvent properties for the kerosines and light gas oils at high water-to-dioxane ratios. Likewise, kerosines and light gas oils were chosen because the naphthalenes alone are present. No other polynuclear aromatics appear because of their higher boiling ranges.

Fig. 3—Commercial model of visible recording polarograph

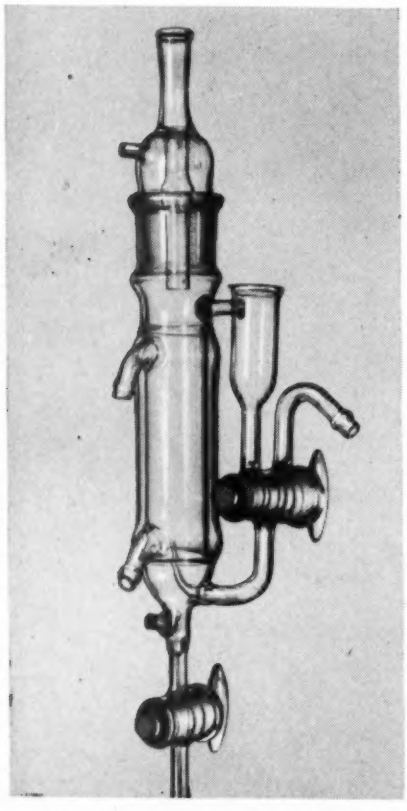


Fig. 2—Polarograph cell similar to that used for determination of naphthalenes in kerosine or gas oil.

The polarographic cell used was similar to that shown in Fig. 2; the measuring and recording instrument is shown in Fig. 3. The cell used by Burdett and Gordon had a capacity of 13 cc. and its ground glass (male) upper surface served as the seat for the upper half of a 24/40 ground glass sleeve which carried the capillary and a rubber stopper; the latter was to keep the capillary in a vertical position at all times. Stopcock at the bottom of the cell simplifies cleaning and also collection of mercury.

The two-way stopcock on the right side in Fig. 2 was modified so that nitrogen could be admitted either to the bottom of the cell or near the top at will. This permitted agitation of the sample before the determination, and passage of a gentle stream over the sample to exclude entry of oxygen during the run. In the cell of Fig. 2 only bottom entry of gas could be achieved. Constant temperature was maintained by circulating water through the jacket surrounding the cell.

Dioxane must be freshly purified before use by refluxing over sodium hydroxide, distilling, and refluxing over sodium until a 1° C. boiling range fraction is secured. Likewise the tetra-*n*-butylammonium iodide should be twice recrystallized from anhydrous ethyl acetate. For calibration (total naphthalenes) pure naphthalenes also should be recrystallized from ethanol or by regeneration from their picrates. The naphthalene solvent (kerosine) was prepared by Burdett and Gordon by percolating a sample of straight-run kerosine over a 2.8 by 240 cm. column of Davison 28 to 200-mesh silica gel and eluting with methanol; the first cuts, having a refractive index less than 1.4520 at 20° C., were combined as the solvent.

Electroyte-solvent was an 85 vol.-% solution of dioxane in water, with sufficient tetra-*n*-butylammonium iodide added to make a 0.10 M. solution. These proportions were selected to give as high a solubility for kerosine and light gas oil as possible and simultaneously to permit a fairly sensitive response of the polarograph to small concentrations of naphthalene.

In calibration, various quantities of pure naphthalene, acenaphthene, and alpha and beta methylnaphthalenes were dissolved in kerosine. Sample then is weighed into a 10 ml. volumetric flask from a 2 ml. Lunge pipette (usually no more than 0.32 g. kerosine or 0.25 g. of light gas oil will dissolve in 10 ml. of the solvent), which then is diluted to the mark with solvent. Transfer mixed sample to the cell.

Nitrogen, previously saturated with electrolyte by passing through a

scrubber containing 85% dioxane-water solution, is bubbled through the solution for 13 minutes; capillary is inserted and scrubbing continued for two minutes. Nitrogen then is diverted to pass over the sample and the polaragram is recorded between minus 1.80 to minus 2.30 v. Potential of the internal anode was minus 0.443 v. against the saturated calomel electrode.

Wave height is determined by subtracting residual current from the diffusion current at minus 2.30 v. impressed potential. Immediately upon completing the polarogram withdraw the capillary, rinse it with acetone and dry.

Experimental data presented by Burdett and Gordon indicate the relation between current passing through the solution and increasing concentration of naphthalenes is linear, also that the calibration curves for the different naphthalenes studied fall very close together (within 2.5%).

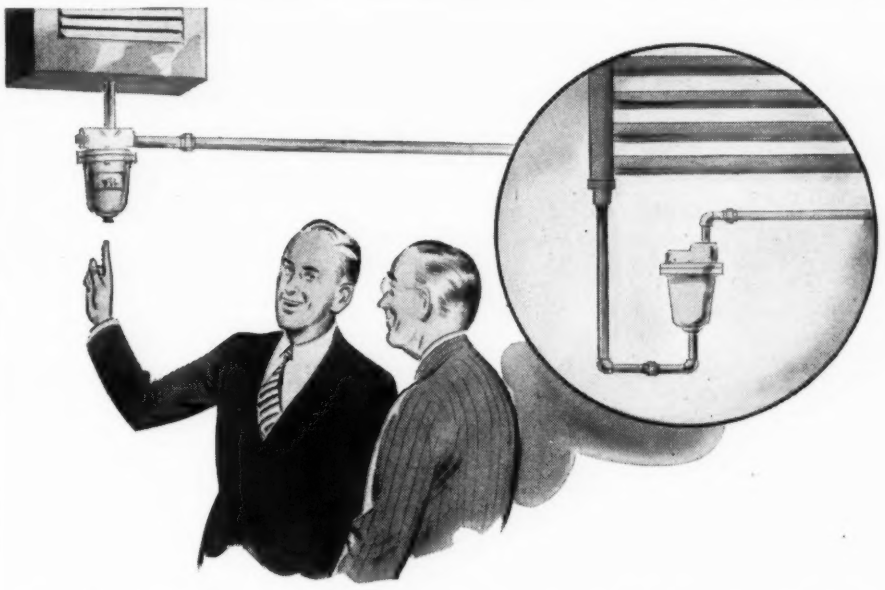
Further investigations have revealed that the alkyl and naphthenyl benzenes present in the boiling range close to the naphthalenes do not interfere. Indene, an olefinic aromatic whose polarographic wave also appears at the same potential as the naphthalenes can be detected because the wave has no plateau; instead, continues to rise until the decomposition potential of the electrolyte is reached.

Biphenyl will interfere if present in equal or smaller quantities than the naphthalenes. It can be detected if acenaphthene is not present by the appearance of a slight plateau where acenaphthene would be expectd. If acenaphthene is present, the biphenyl wave appears with it as a single wave. Higher bicyclic aromatics, or olefinic aromatics having double bonds conjugated with the ring, also interfere but they usually can be eliminated readily by distillation. If all the acetone is not removed from cell or capillary, traces remaining from a previous washing, its presence will result in erratic residual and diffusion currents.

Table 1 represents an application of this method to the analysis for total naphthalenes of several refinery stocks. Some samples were cracked while others were straight-run. The close agreement between successive runs will be noted, even though sample weights dissolved in the electrolyte varied widely. The results are expressed in millimoles per kilogram of unknown rather than weight-percent for convenience and because of the similarity of calibration curves when expressing results on a molal basis. To convert to weight-percent, millimoles per kilogram should be multiplied by an average molecular weight for the naphthalenes and divided by 10,000.

TABLE 1—Polarograph Analysis of Unknowns for Total Naphthalenes

Sample	Weight in 10 Ml. of Electrolyte-Solvent Gram	Wave Height Microamperes	Naphthalenes per Liter of Electrolyte-Solvent Millimoles	Naphthalenes per Kg. of Sample Millimoles
1	0.1618	10.40	3.17	196
	0.1082	7.28	2.22	205
2	0.1442	9.38	2.86	198
	0.1612	10.69	3.26	202
3	0.1122	5.90	1.80	160
	0.1996	10.33	3.15	158
4	0.1059	10.43	3.18	300
	0.1020	9.74	2.97	291
5	0.0798	8.82	2.69	337
	0.1289	15.68	4.78	371
6	0.1205	9.12	2.78	231
	0.1191	8.95	2.73	229
7	0.1346	8.04	2.45	182
	0.1275	7.58	2.31	181



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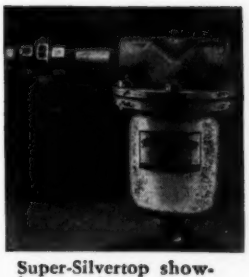
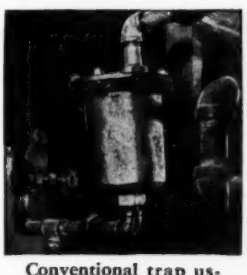
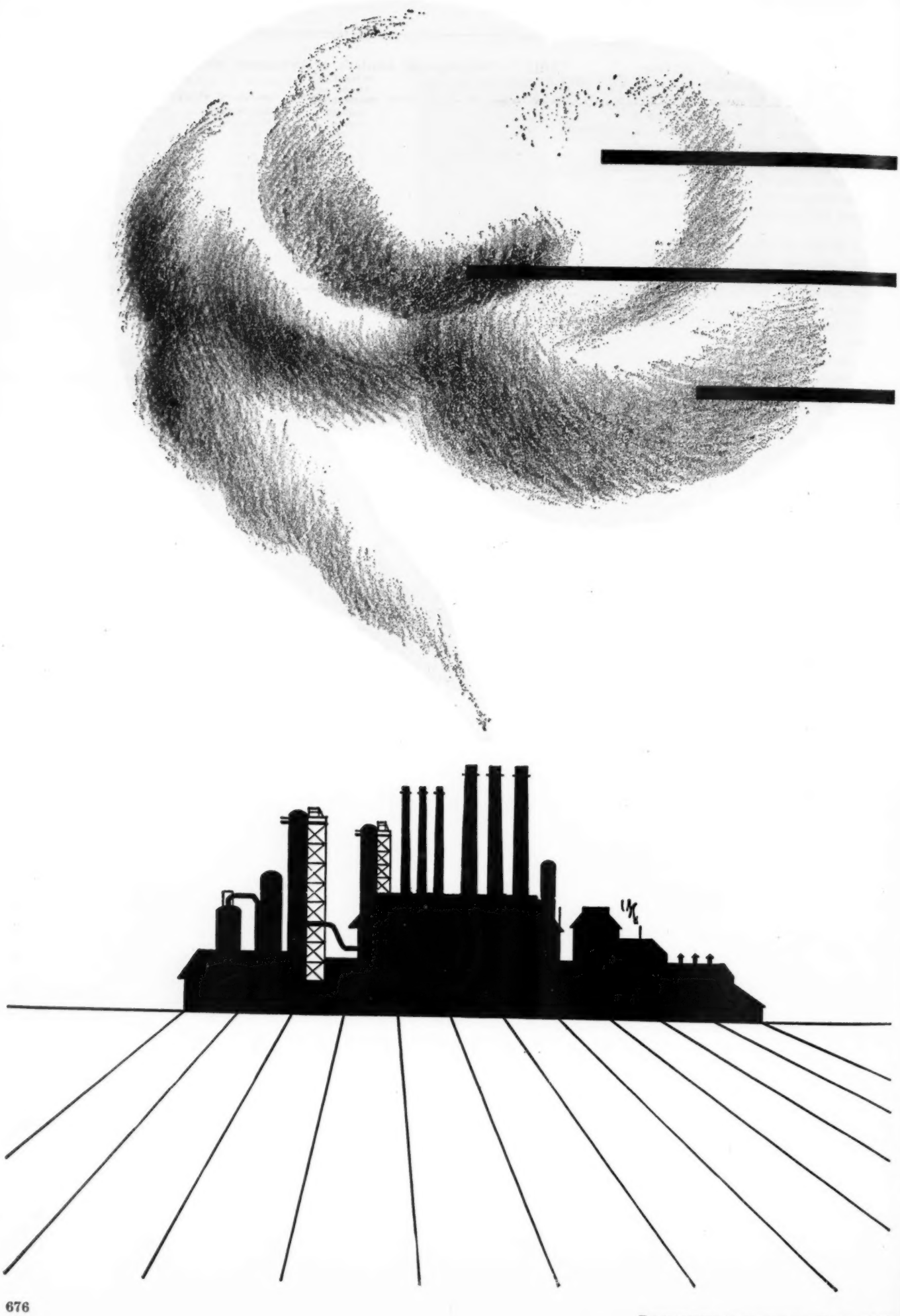


Super-Silvertop showing one nipple and one union needed.



Conventional trap using seven fittings and two unions.



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PROPERTIES

	No. 5	No. 6
Specific Gravity at 60°/60° F. . .	0.91	0.91
Pounds per Gallon at 60° F.	7.57	7.57
Flash Point (Tag C.C.), ° F.	60	60
Viscosity at 100° F., S.U.S.	41	41
Solidification Temperature, ° F.	—20	0

Du Pont Gasoline Antioxidant No. 22

Antioxidant No. 22 is a commercial grade of N:N′-disecondary-butyl-para-phenylene-diamine containing no solvents.

PROPERTIES

Specific Gravity at 60°/60° F.	0.94
Pounds per Gallon at 60° F.	7.67
Flash Point (C.O.C.) ° F.	290
Viscosity at 100° F., S.U.S.	64
Solubility in Water at 80° F., Weight %	< 0.05
Solubility in Gasoline at 80° F.	In all proportions

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THE DERIVATIVE CONTROLLER

Compound Proportioning Bellows Construction

By VINCENT V. TIVY,
The Foxboro Co.

Automatic controllers are sensitive not only to changes in the process they control but also to effects which do not originate within the process itself, so-called "extraneous influences." For example: in a line in which the temperature of one fluid is controlled by the addition of a second fluid, insufficient mixing before the flow reaches the controller's measuring element creates stratification, or layers of varying temperature. Such variations influence the operation of the instrument by effecting minute rapid responses in the motion of the pen. Other extraneous influences cited are mechanical jarring and vibration.

A derivative controller can segregate these influences and either ignore or correct for them before transmitting its responses to the control valve which it actuates. The author explains the action of the derivative controller in overcoming such operating problems.

THE purpose of a controller is to detect and correct for changes in the process being regulated. The controller, however, responds only to pen motions in accordance with which it positions an automatic valve. The pen is actuated by an element which responds to condition changes which may, or may not, originate in the process. If the controller were sensitive only to changes in the process, there would be no need of this paper, but since some of the motions of the measuring *element do not originate in the process,* it is important to consider all motions of the measuring pen in the light of the valve action that will be obtained as a result of them.

Pen motions may be grouped into two classes:

1. All motions produced by changes in the process that originate within the process and which are indicative of real changes in the process variable which is being controlled. (A controller should recognize and correct for these motions.)

2. All other motions of the pen, some of which originate outside the process. (A controller should not recognize these and any attempt to correct for them is useless and will result in disturbances in the process.) For the purpose of this discussion these motions of the pen will be called "extraneous influences".

These extraneous influences may be caused by one or more of the following conditions:

1. Changes detected by the measuring element, but which occur locally and do not travel through the process. It has been found in practice that such variations do occur, but they are invariably of small magnitude, short duration and take place at a fast rate. An example of such an influence can be cited in the case of a controller whose thermal element is in a pipe carrying a fluid whose temperature is controlled by varying the rate of input of a second fluid which is mixed into the first ahead of the element.

If the stream is not thoroughly mixed before reaching the measuring element, the resulting stratification will cause the element to register temperature changes as it is influenced by successive strata passing over its sensitive portion. These variations as detected by the element will be very *rapid* and in fact will include only the time lag of the measuring system; also, they will be of small magnitude.

2. Mechanical jarring or similar effects.

3. Vibration of the instrument.

Since controllers in general cannot distinguish between the motions which should be corrected for and those which should not, many applications become quite difficult to handle. A controller which can segregate these motions and either correct for or ignore them, as required, is the Foxboro Derivative Controller and the purpose of this paper is to show how this result is accomplished.

The condition which permits the

Meet the Author

Vincent V. Tivy, manager of refinery instrument sales, the Foxboro Co., has been connected with instrument engineering work for most of his working years.

Born in Guatemala, of English parents, he was educated in England and served at sea as a junior engineering officer in the Royal Navy. He became an instrument engineer with the firm of George Kent, Ltd., and in 1938 went to Trinidad as instrument engineer with Trinidad Leaseholds, Ltd., later supervising instrument installation and maintenance in that company' refineries. This work led to a connection with Neal & Massy Engineering Co., of Trinidad, directing sales and servicing of instrumentation to the petroleum and sugar industries in the West Indies.

During the war Mr. Tivy became associated with M. W. Kellogg Co., in New York, supervising installation and start-up of processing and control instruments in new refineries in the U. S. He since joined the Foxboro company, where one of his special fields of study is the application of electronic-type instruments to modern petroleum refining methods. Mr. Tivy has had a number of technical papers published on various aspects of instrument engineering, and also is a frequent speaker on the principles of process control and instrument design. Making his home in Foxboro, Mass., he is married and has two small sons.

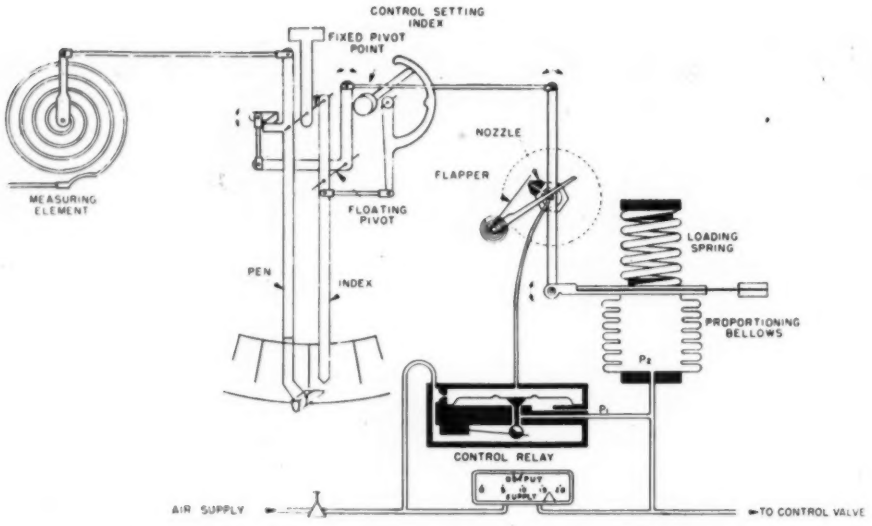


Fig. 1—Pneumatic circuit of a typical proportional controller

instrument to select the motions which require correction as opposed to those which should be ignored is that generally the extraneous influences are of small magnitude and occur much faster than those motions originating in the process. The Derivative Controller makes its selection and applies appropriate corrections on the basis of *rate* and *time*.

How "Rate Response" Is Obtained

The pneumatic proportioning mechanism of a proportional controller is also the basic mechanism of a derivative controller. The operating principles of this mechanism will therefore be reviewed and should be clearly understood as a preliminary to understanding the principles of a derivative controller.

The pneumatic circuit of a typical proportional controller is shown in Fig. 1. It is important to remember one basic fact, true of any pneumatic proportional controller. Where the controller's output pressure is between 0 and 17 psi (where the supply pressure is 17 psi) the flapper is "tangent" to the nozzle. (The flapper is said to be "tangent" to the nozzle when it is in such position that the pressure in the relay diaphragm will hold the inlet and exhaust ports neither wide open nor fully closed.)

While the "tangent" position is not an exact point, the range of distance through which the flapper can move (the nozzle throttle-band) and remain "tangent" is so small that for the purpose of this discussion it may be considered a fixed point.

From this it is seen that any motion of the flapper to or from the nozzle will cause the relay to throw toward the wide open or fully closed position and remain there until the flapper has been returned to the tangential position by the resulting motion of the proportioning bellows.

Stated differently, it may be said that any motion of the flapper will *immediately* result in a change in relay output pressure (P1) sufficient to cause the pressure in the proportioning bellows (P2) to reposition the flapper (proportioning follow-up action). Thus while P2 must bear a fixed relationship to flapper or pen position, P1 does not necessarily maintain this relation. It will only do so when it can be shown that P1 and P2 are always the same.

The features of the proportioning mechanism which should be kept in mind are:

1. The air pressure P2 in the proportioning bellows is always *equal* to the control relay output pressure P1, and always exactly proportional to the movement of the measuring system within the limits of the proportioning band.

2. These pressures P1 and P2 always change at a *rate* exactly proportional to the rate of measurement change.

3. Therefore, the *air flow* into or out of the proportioning bellows must be at a rate proportional to the rate of measurement change. (This statement is based on the capacity of the bellows remaining constant, and while this is not exactly so, the capacity change is sufficiently small that it may be ignored.)

The essential part of a simple type of proportional plus derivative controller is shown in Fig. 2. It is apparent that the only difference be-

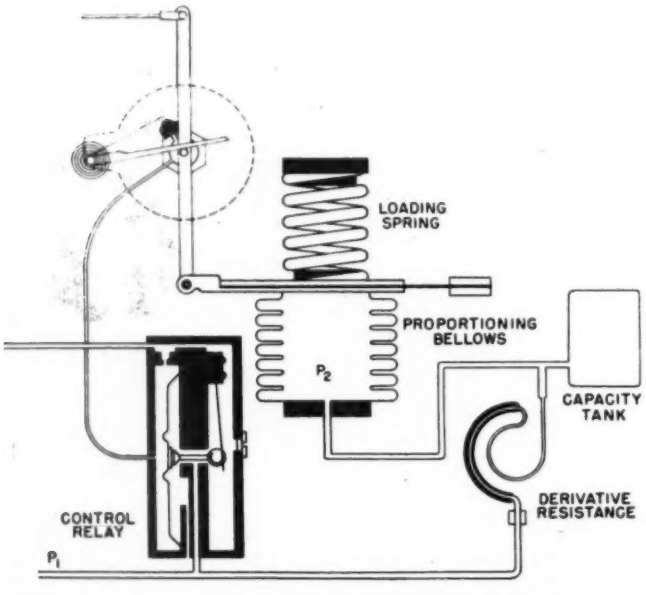


Fig. 2—A simple type of proportional plus derivative controller

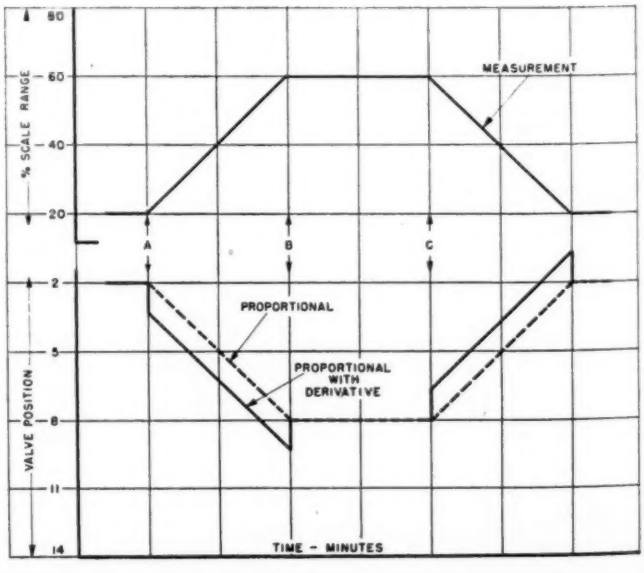
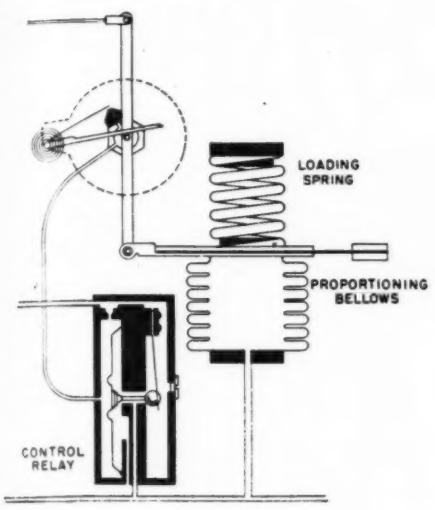


Fig. 3—Comparison of output pressures of a proportional and a proportional plus derivative controller



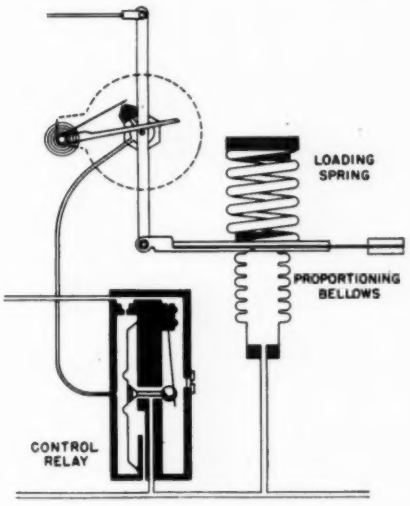


Fig. 4—Essential pneumatic circuits of two proportional controllers, one with a larger size proportioning bellows

tween it and the proportional controller is the addition of the derivative resistance between the output of the control relay and the proportioning bellows.

In the derivative controller, Fig. 2, as in the proportional controller, the pressure P2 in the proportioning bellows is always *exactly* proportional to pen position and under conditions of measurement change it changes at a rate *exactly* proportional to pen rate. Also under conditions of change the flow of air into or out of the proportioning bellows is proportional to pen rate.

As has been established previously, the output P1 of the control relay will be at whatever pressure is required to cause air to flow into or out of the proportioning bellows to maintain P2 at the pressure determined by the pen position. It is apparent that under static conditions the pressure P1 and P2 in this Fig. 2 will be the same, but that under conditions of measurement change and because of the resistance to air flow between relay and proportioning bellows the pressures P1 and P2 must be different.

Where air is flowing through a capillary-type resistance the pressure drop across that resistance is proportional to the rate of air flow through it. In the case of this derivative controller, since the rate of air flow through the derivative resistance is proportional to pen motion, a pressure drop across this resistance exists which is also proportional to the pen motion.

The output pressure of the derivative controller is therefore exactly the same as that obtained with a proportional controller plus or minus an amount which is the pressure drop across the derivative resistance. Since this pressure drop is proportional to pen rate, it follows that the output pressure of the derivative controller is the same as a similarly adjusted proportional controller, plus or minus an *amount proportional to pen rate.* This is known as the "rate response" or "derivative effect".

Fig. 3 compares the output pressures of two controllers similar in all respects except that one includes the derivative function where the other does not. The top curve shows a motion applied to the measurement while the bottom curve traces the output pressure of the controller responding to the measurement change shown above.

It will be noticed that at the moment of pen deviation (A) at a given rate, the output of the derivative controller is increased an amount which is proportional to that rate and maintained at that lead over the

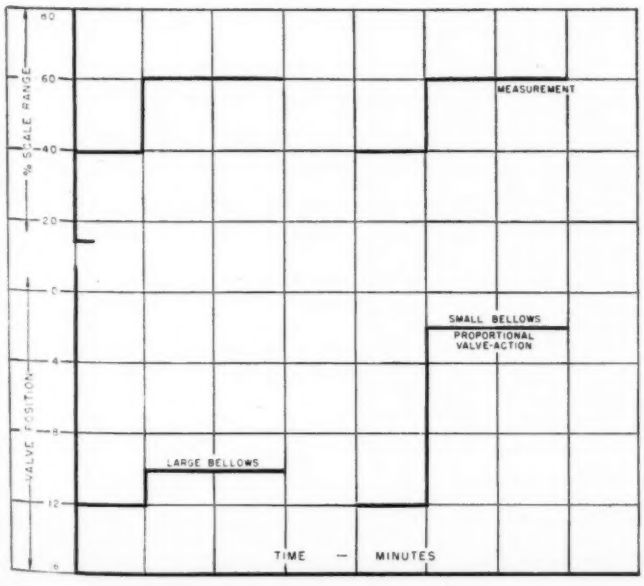


Fig. 5—Comparison of pen motion of controllers shown in Fig. 4

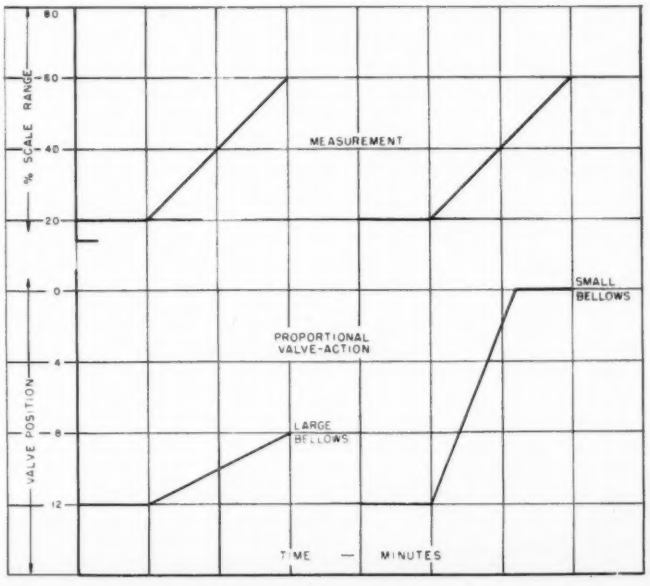


Fig. 6—Output pressures for continuing deviations of the pen where the pen motions in both cases are the same

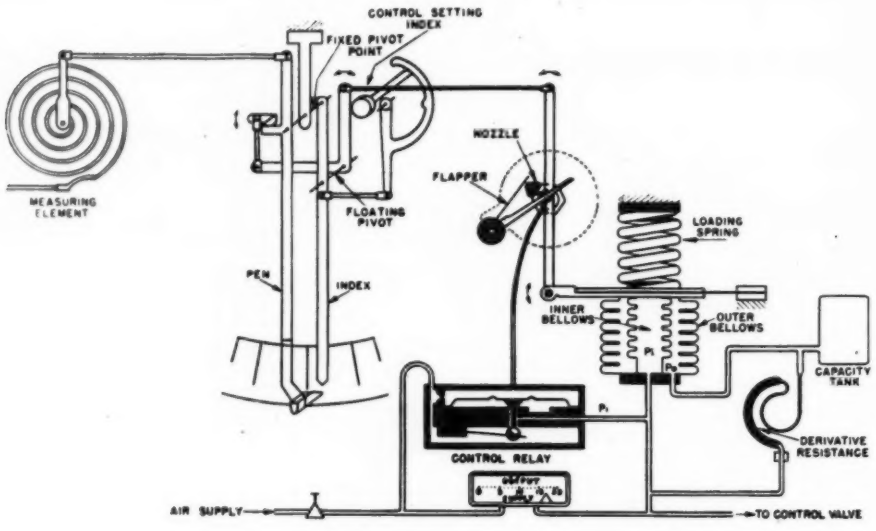


Fig. 7—Design for a controller combining the actions of those shown in Fig. 4

proportional controller as long as that rate is maintained. As soon as the measurement *rate* ceases, (B) the derivative effect is withdrawn and does not appear again until there is a further rate of change of measurement (C) in this case in the opposite direction, calling for a derivative effect in the other direction also.

It is important to realize that the derivative effect is proportional to pen *rate* only, and that it will be the same for a given rate of pen motion, entirely regardless of the distance through which the pen moves.

Derivative Controller with Compound Bellows

Fig. 4 shows the essential pneumatic circuits of two proportional controllers with but one difference, namely, the size of the proportioning bellows. We can review what the output pressures from these two controllers will be for equal measurement changes.

In order to simplify the following discussion while we are combining two bellows, it is well to establish some common denominator. This denominator can be the force exerted by the proportioning bellows against the flexure and loading springs.

In order for the flapper and nozzle to maintain their required relationship, the outer end of the flexure spring must be in a position proportional to measurement at all times. Hence, regardless of the pressure in the proportioning bellows, the *force* exerted by it upon the flexure spring must be *proportional to the measurement.*

Thus, in the case of the two controllers shown in Fig. 4, for any given change of the measurement the force change exerted on the flexure springs by their respective bellows must be the same. Because the area of the bellows is in a ratio of 1:5, the pressure change in the small bellows will be five times the pressure change in the large bellows.

In Fig. 5 we plot a motion that may be applied to the pen of each of the two Controllers illustrated in Fig. 3, and immediately below these two identical lines we plot the output pressure resulting from these motions. The shapes of all four curves are similar except that in the case of the controller with the smaller bellows the output pressure change is much larger than that of the controller with the large bellows.

In Fig. 6 we plot the output pressures for continuing deviations of the pen where the motions of the pens in both cases are the same. The output pressure changes are different in the same ratio as before. It will be noticed that in the case of the controller with the smaller bellows the output pressure reaches 0 psi, beyond which it cannot go, and hence the proportional relationship is no longer maintained, and the flapper is not held tangent to the nozzle for the remainder of the measurement motion. (The controller is said to be outside its proportioning band when this condition occurs.)

If we were to build the controller as shown in Fig. 7 with the size of the outer proportional bellows the same as the larger bellows unit in Fig. 4, and with the size of the inner bellows the same as the righthand figure in Fig. 4, and put an adjustable resistance between the two bellows, we could reproduce the curves shown in Figs. 5 and 6.

With the adjustable resistance wide open, the controller would perform exactly like the one with the larger bellows, because the output pressure of the relay would be applied in the inner and outer bellows simultaneously. Hence, the bellows area subjected to relay pressure, would be the same as that in the simple derivative controller with the larger bellows.

If the resistance were closed completely the controller would behave like that with the smaller bellows, because the relay output pressure would not be applied in the outer bellows.

When we combine the large and small bellows into one unit, the sum of the forces exerted by them on the flexure spring must be the same as in the case of the units with the single bellows construction, and therefore, for any *motion of the pen* the pressures in the two bellows will adjust themselves so that when multiplied by their respective areas they will produce a *total force change* the same as previously obtained, as shown in the following equation:

$$P_i \frac{x}{5} + P_o \frac{4x}{5} = \text{Force change}$$

Where:

P_i = Pressure change in inner bellows

P_o = Pressure change in outer bellows

x = Total area of inner and outer bellows

We can plot, therefore, the output pressures resulting from a sudden motion of the measurement (pen movement) with zero, intermediate and infinite values of the derivative resistance. This is done in Fig. 8. The two solid lines *in the lower curve,* represent the output pressures resulting from the measurement change shown in the upper curve where the derivative resistances are 0 and infinity respectively. (It will be noticed that these curves are taken from Fig. 5.)

Considering the case where the derivative resistance is at an intermediate setting, during the momentary period while the pen is in motion (and realizing that this motion is at an infinite rate) the effect of the outer bellows will be nil (because air will not have had time to flow through the derivative resistance) so the output pressure will build up to the upper solid line. At this moment $P_i = 10$ and $P_o = 0$; hence the change in total force on the flexure spring equals $10\ x/5$.

As soon as the pressure in the inner bellows is greater than that obtaining in the outer bellows, air will start to flow through the resistance, increasing the pressure in the outer bellows and thereby increasing the force exerted by it upon the spring. This will result in a reduction in output (or inner bellows

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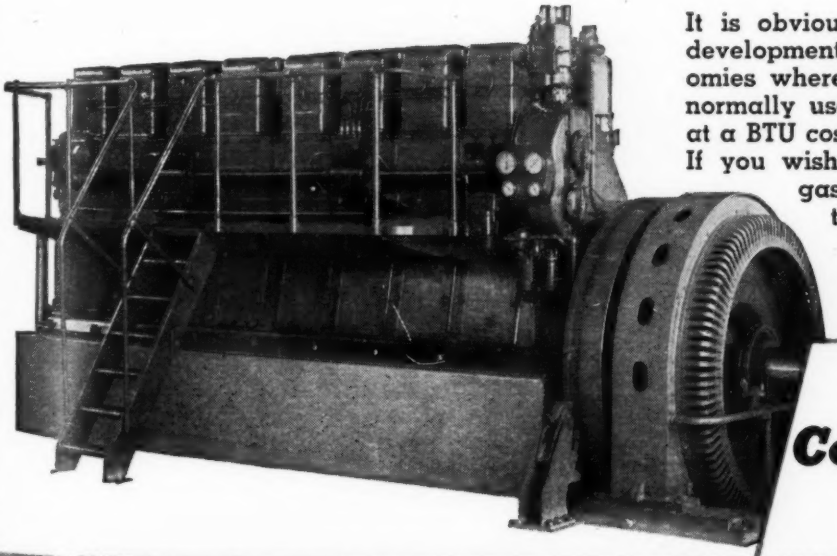
TOTAL BTU/BHP/HR

ENGINE TYPE	100% load	75% load	50% load	25% load
Spark-ignited gas engine	9,500	10,000	12,000	17,800
Supercharged oil Diesel	7,400	7,450	7,950	9,250
Supercharged gas-Diesel (ordinary)	7,200	8,600	12,000	20,500
C-B supercharged gas-Diesel (new)	6,400	6,750	7,350	8,950



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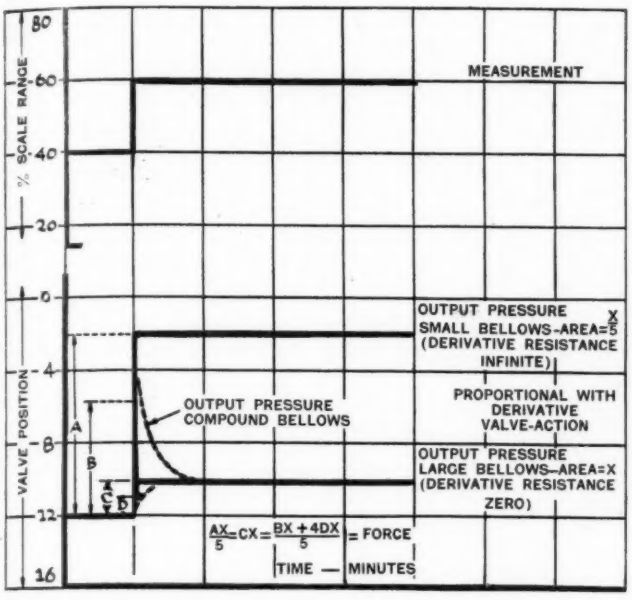


Fig. 8 — Output pressure curves resulting from the controller with compound bellows shown in Fig. 7

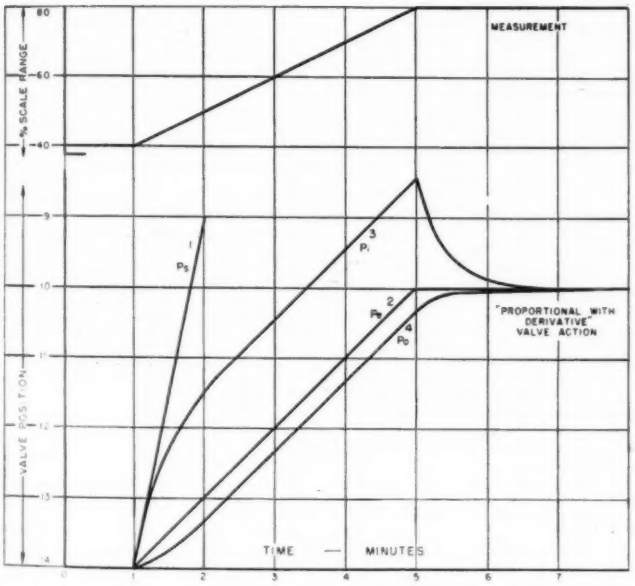


Fig. 9 — Output pressures with varying settings of the derivative resistance.

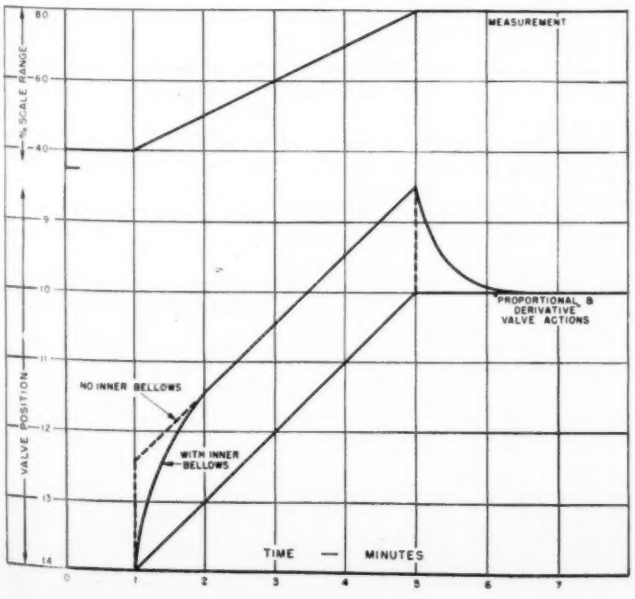


Fig. 10 — Comparison of output pressures of a proportional controller with a derivative controller with no inner bellows and with compound proportioning bellows

pressure) so that the total force remains equal to 10 x/5. For example when $P_o = 1$ (D in Fig. 8) we can determine what P_i is from the equation:

$$P_i \frac{x}{5} + \frac{4x}{5} = 10\frac{x}{5}$$

dividing by $\frac{x}{5}$, and rearranging,

$P_i = 10 - 4$
$= 6$ (which is shown as B in Fig. 7).

As long as there is no further motion of the measurement, the pressures will continue to equalize along the dotted exponential curves. The time taken for these pressures to change 63% of the difference between the initial and final values is the derivative time constant.

Fig. 9 shows a continuing motion of the measurement. Curves 1 and 2 (taken from Fig. 6) are output pressures with the derivative resistance at values of infinity and zero respectively. Curve 3 is the output pressure of the compound bellows unit with an intermediate setting of the derivative resistance. This is the pressure in the inner bellows. Curve 4 is the pressure in the outer bellows.

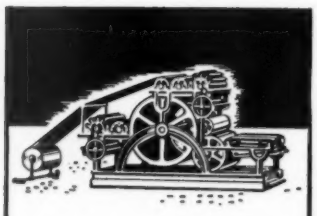
Curves 3 and 4 are derived as follows: At the moment of pen departure at a fixed rate the output pressure will start off, tangent to the Curve 1, which is the pressure in the inner bellows. The moment that the pressure drop across the derivative resistance is higher than 0, air will begin to bleed through it, building up the pressure in the outer bellows.

As the *rate* of pressure build-up in the outer bellows increases, the *rate* of output pressure increase must be reduced in order that the total force change applied to the flexure spring will always be proportional to the measurement change. This force will always be equal to the pressure represented by Curve 2 multiplied by the sum of the areas of the two bellows. Eventually the output pressure 3 stabilizes at a point higher than 4, and sufficiently high so that it can cause air to continue to flow through the derivative resistance at a rate *proportional to the rate of pen deviation.*

The pressure relation of the four curves is established in the same manner as before.

$$P_s \cdot \frac{x}{5} = P_o \cdot \frac{4x}{5}$$
$$= P_i \cdot \frac{x}{5} + P_o \cdot \frac{4x}{5}$$

Where
P_i = Pressure in inner bellows, compound unit, (Curve 3)



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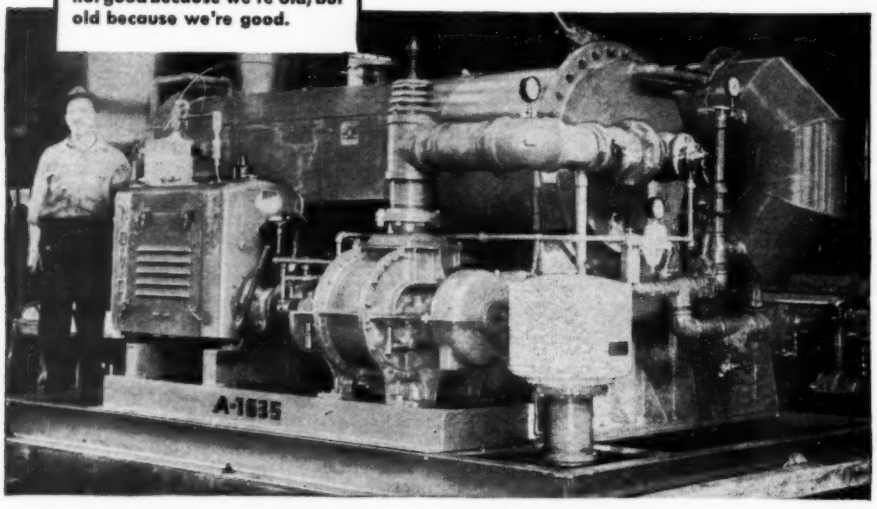

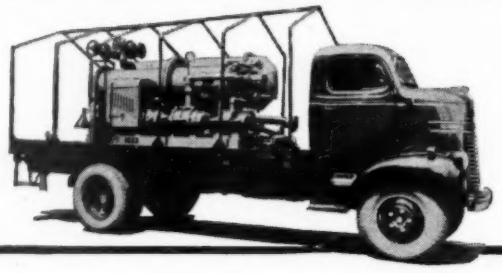

(Above) R-C Inert Gas Generator in oil refinery. Oil-fired, engine-driven. Capacity 45,000 CFH.

(Left) Portable unit, on truck, for fast service by public utility. Capacity 15,000 CFH.

Wherever inflammable gases or liquids are processed, handled or stored, there exists danger of fire or explosion. Such hazards are minimized in many plants with R-C Inert Gas Generators, which produce cheaply a mixture of nitrogen and carbon dioxide, in either stationary or portable units, with oil or gas for fuel.

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P_o = Pressure in outer bellows, compound unit, (Curve 4)
P_s = Pressure in small bellows, simple unit, (Curve 1)
P_l = Pressure in large bellows, simple unit, (Curve 2)
x = Area of large bellows = Total area of inner and outer bellows.

It will be noted that the moment that the pen ceases to move, the pressure in the two bellows will start to equalize and will follow the pattern established in Fig. 8. From observation of these curves it can be seen that the output pressure of the compound bellows controller is, for the greater part of the time, similar to that of a similarly adjusted proportional controller plus an amount proportional to the rate of measurement change.

This relationship does not hold exactly true at the very start or final points of pen movement, but it has been shown experimentally that this small difference in the derivative effect at one or the other end has very little over-all effect upon the control of a process.

It is interesting at this juncture to compare the output pressure of a proportional controller with 1) a derivative controller with no inner bellows and 2) a derivative controller using the compound proportioning bellows.

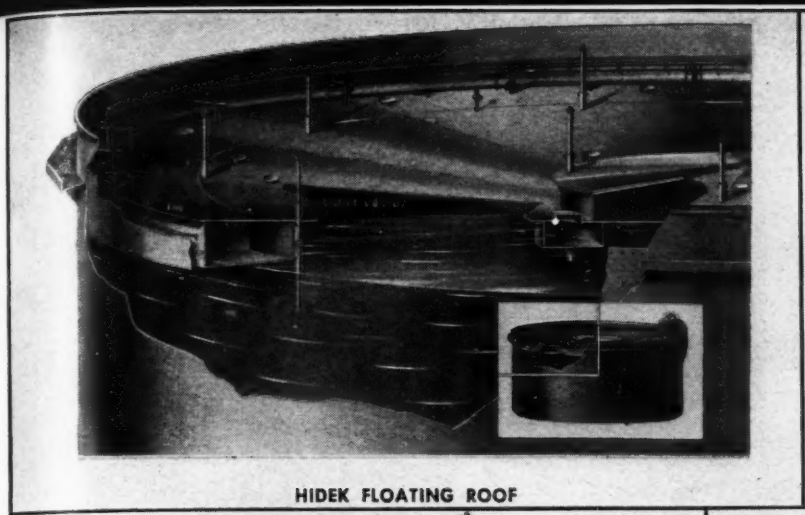
In Fig. 10 we plot the three output pressures, and it will be seen at once that the over-all difference between the two types of derivative is in effect quite small.

Conclusion

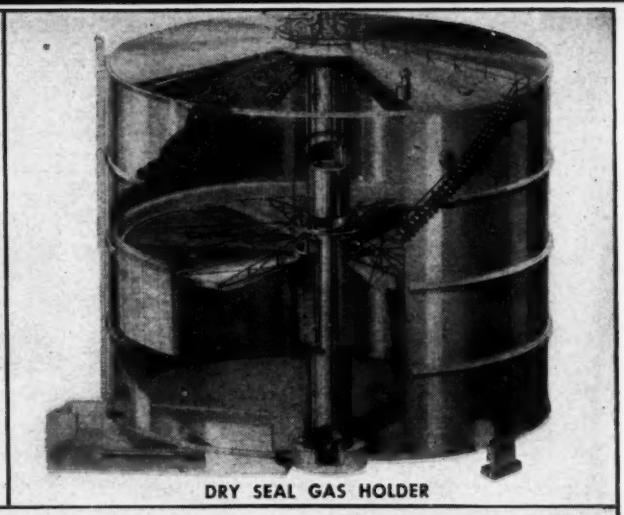
As stated previously, the purpose of the compound bellows construction is to reduce to a minimum the reactions of the controller to extraneous influences. These influences were described as being of small magnitude and occurring at a rate faster than the normal reaction of the process. It is convenient, therefore, to reproduce Fig. 10 for different rates of pen motion, showing only the first part of the curve, since we are interested only in small rapid motions of the measurement.

In Fig. 11 a number of measurement motions are plotted with the resultant output pressures of controllers using first, the simple bellows and second, the compound bellows construction. For the purpose of comparison two dotted lines show the output pressure that would obtain for the same rate of change, and plotted at an elapsed time of 6 sec.

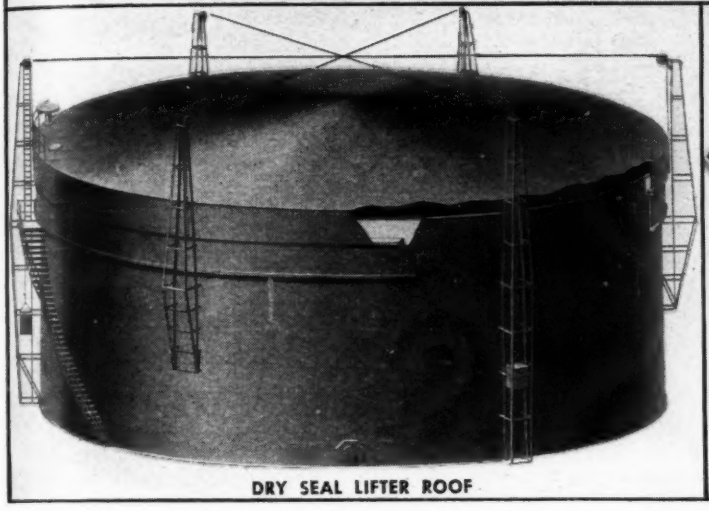
One curve shows the position that would have been reached after that time with the simple bellows construction for the different rates of change, while the other shows the same for the compound bellows construction. It is at once apparent how much less the output change is



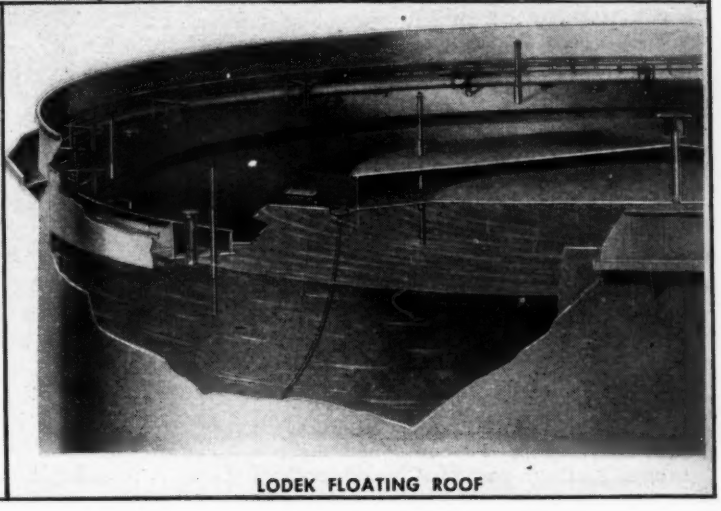
HIDEK FLOATING ROOF



DRY SEAL GAS HOLDER



DRY SEAL LIFTER ROOF



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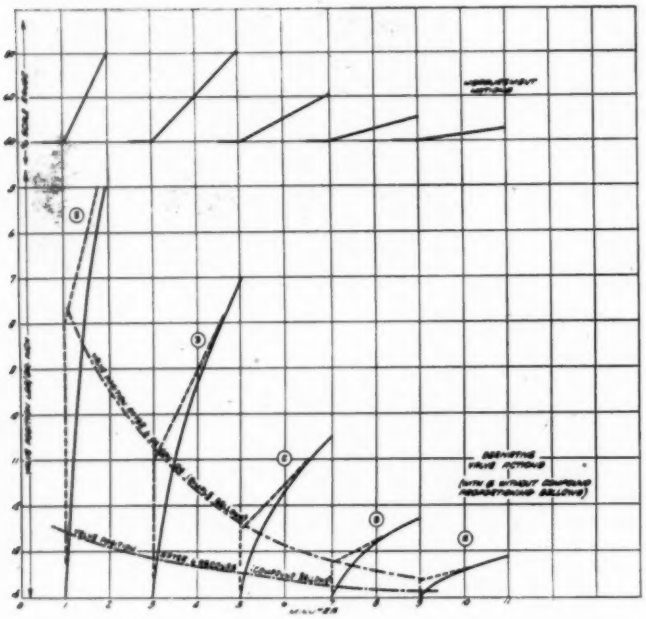


Fig. 11—Derivative valve actions using simple bellows and compound bellows construction, showing position after six seconds

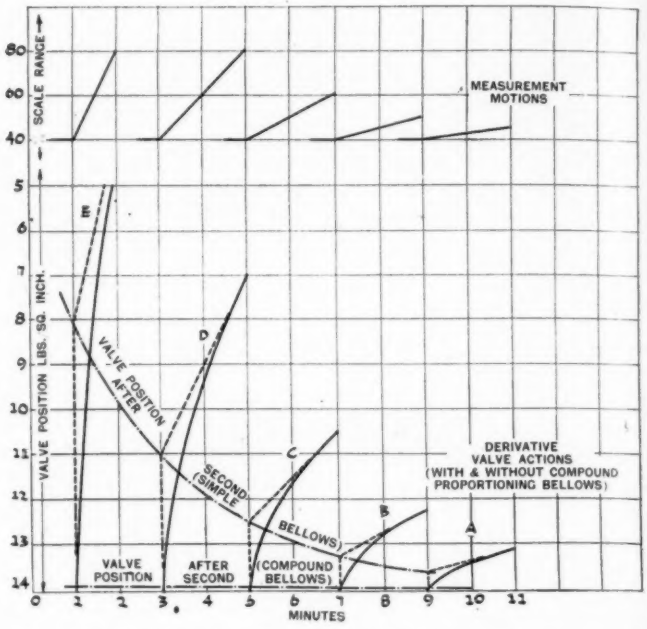


Fig. 12—Derivative valve actions using simple and compound bellows construction, showing position after one second

in the case of the compound bellows construction, and how much greater the difference is between the two derivative types with faster motions of the measurement.

In actual practice, an extraneous influence would never continue for a period as long as 6 sec., and therefore these two curves show changes resulting from extended influences which are much greater than would normally be the case. In Fig. 12 we reproduce these curves and show the changes in valve position that would occur after an elapsed time of one second. It will be noticed that the change in valve position of the derivative controller using the compound - bellows - construction is very small, while in the case of the simple bellows construction the output pressure has changed very considerably, particularly in the case of a fast rate of change.

The general conclusion that may be drawn from these curves is that for normal rates of change representing normal process changes, the derivative controller reacts similarly whether it uses the simple or the compound bellows construction. However, the derivative controller using the compound bellows construction will substantially ignore those changes produced by extraneous influences. The simple bellows construction, on the other hand, must react to them as if they were normal process changes.

The derivative function as embodied in the compound bellows controller may be stated as being to provide a very powerful stabilizing influence. When the derivative time is at the correct value, it results in the controller being more stable, so that its proportional band width may be materially improved. The amount of improvement becomes more and more noticeable as the process difficulty increases, and it follows therefore that the derivative should always be specified on the more difficult processes which, in general, are often those for the control of temperature.

The foregoing discussion has been based on a proportional controller with derivative, and mention of reset has been omitted to simplify the presentation. The addition of reset to the control system in no way alters the stated facts. An examination of the control system will show that the reset function has no effect upon the operation of the derivative function or vice versa.

The "Hyper-Reset" Controller, shown in Fig. 13 is the well-known Foxboro Stabilog Controller to which derivative has been added, using the compound bellows construction. As has been explained in this discussion, the function of the inner bellows is *not* to produce a derivative effect. This effect is produced by the derivative resistance. The only function of this inner bellows is to modify the pure derivative effect so that the controller will not react significantly to measurement motions produced by extraneous influences.

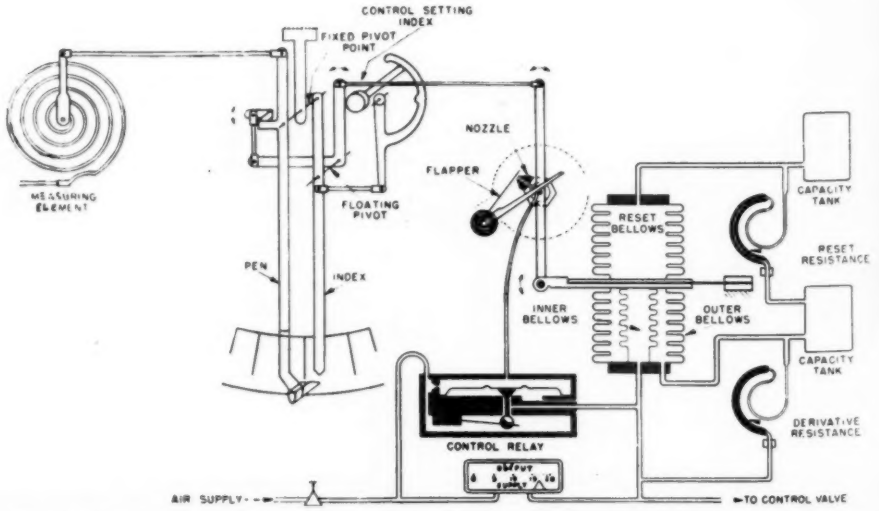
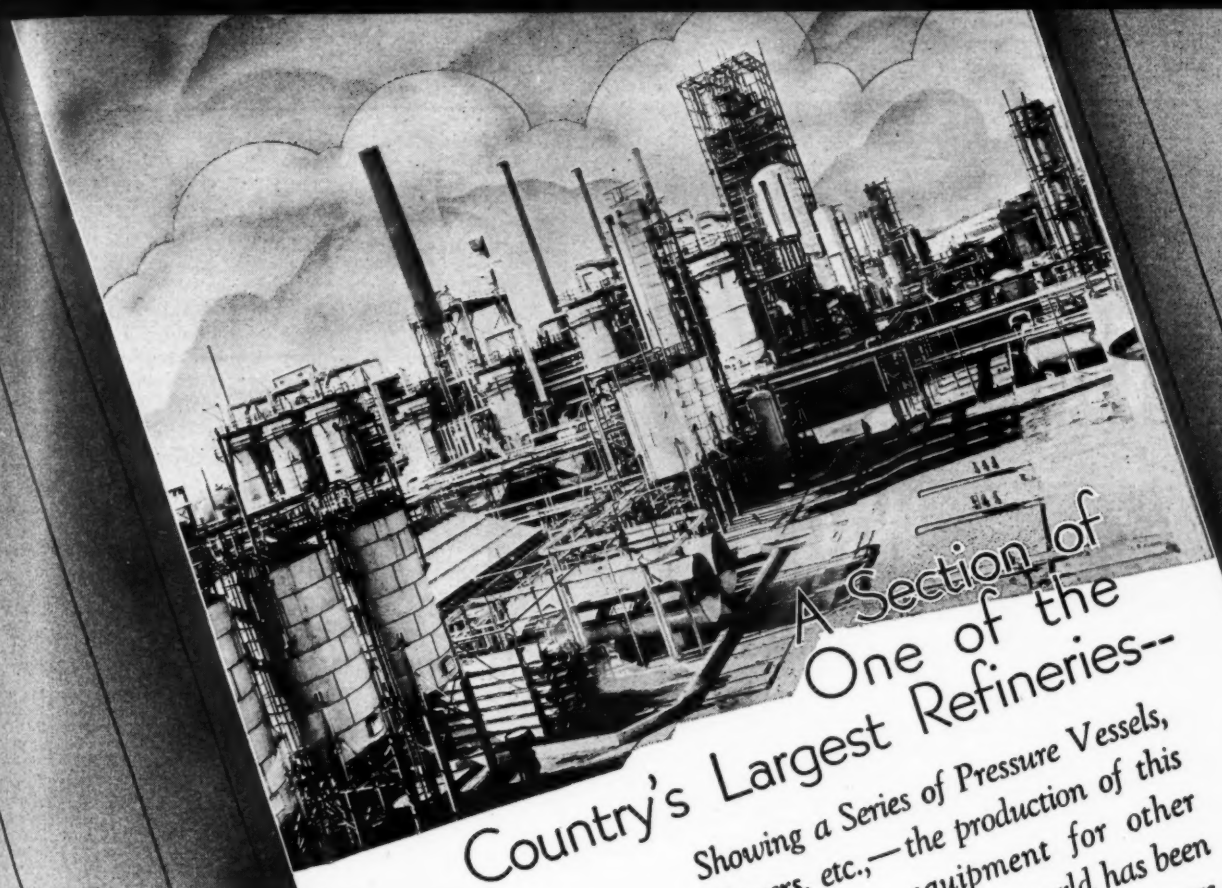


Fig. 13—The "Hyper-Reset" Controller, incorporating compound bellows with derivative action added



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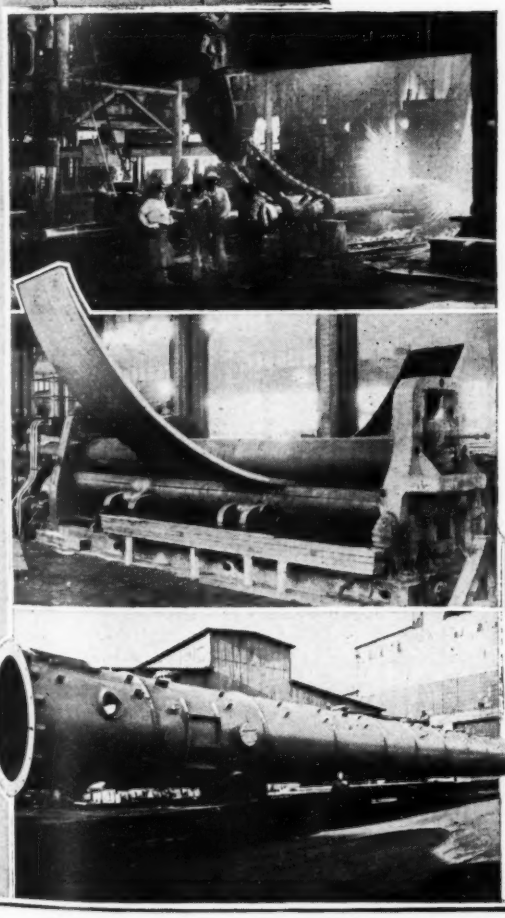

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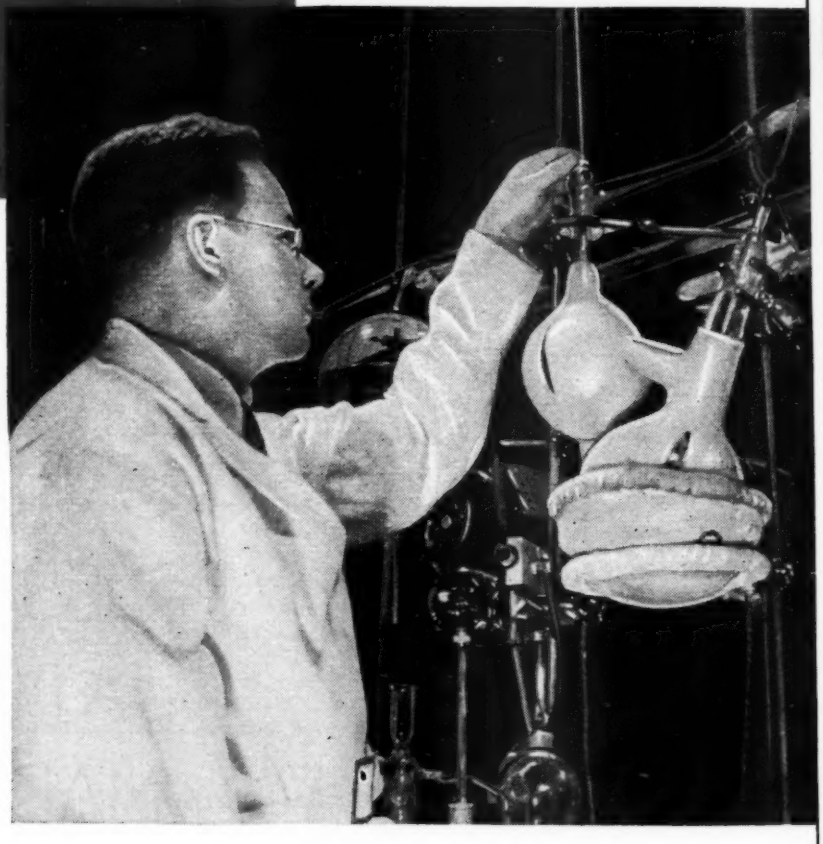

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Patent Trends in Petroleum Refining

By PETER J. GAYLOR

Patent Attorney and Editor "The Technical Survey"

Reducing Tackiness of Asphalted Materials

IN THE MANUFACTURE of protected metal roofing or siding sheets, there is a tendency for the bituminous surfaces to adhere together, while nested, particularly during warm weather.

One solution found for overcoming this difficulty, was to coat the surfaces with an aqueous solution of alginates. However, these developed a distinct and unsavory fish odor, apparently brought about by decomposition during storage of the sheets.

In U. S. patent 2,440,626, H. H. Robertson Co. covers the use of an anti-stick composition having the following analysis:

Low-viscosity methyl cellulose	2 pts.
Glycerine	1 pt.
Sodium salt of sulfated heptadecanol	0.25 pt.

The mixture is diluted with water to the order of 3% "solids" content.

Desalting Oils

TO BE SUCCESSFUL, a desalting process should be able to treat large volumes of oil at a low operating cost, generally a fraction of one cent per barrel. It is not usually necessary to remove the salt completely, but if the amount of salt is reduced from a content of about 50-300 lbs. per 1000 bbls. down to about 5-30 lbs., the resulting oil is usually satisfactory for ordinary refining operations.

At present, there are two main processes commercially employed for desalting: electrical and chemical. In the electrical method, a high voltage alternating field is employed to coalesce the brine particles. In the chemical process, there is mixed with the oil a suitable demulsifying agent, after which the oil is passed through a simple mixing device and coalescer, a baffled pipe or porous mass of sand, gravel, etc. The coalesced droplets of brine are then separated from the oil by gravity settling. In this process, it is usually advantageous to control the hydrogen ion concentration or pH of the oil passed through the coalescer by adding caustic soda until a pH of 6-10 is obtained.

Some difficulty has been encountered in controlling pH by this method, owing to the formation of precipitates from the reaction of added alkali on alkaline earth or other compounds present. In its U. S. patent 2,440,617, Standard Oil Co. (Ind.) prevents the formation of such precipitates, while still obtaining full advantage of pH control in the operation.

The process employed is illustrated by a flow sheet in Fig. 1. Crude oil containing dispersed brine entering line 10 is mixed with treating agent (such as ricinoleic acid, green sulfonic acids, naphthenic acids, etc.) from tank 45 and then led through heat exchangers 14 meeting a stream of heated water from tank 18, the water being at about 200°F. There is also to be added an alkaline brine solution from line 20.

These three liquids are mixed in baffled pipe mixer 21 and run under pressure into coalescer 22 filled with glass wool, sand, or the like, there being a perforated plate 23 provided in tank 22 to allow for removal of any aqueous layer which may separate. The mixture is then run into settler 26 at which point it meets a stream of alkali fed from storage tank 35 through line 37. Desalted oil is drawn off the top of settler 26 (through pipe 29), while the main body of the brine is drawn off the bottom through line 30.

In this patent, a large part of the brine (equivalent to about 20% of the volume of oil charged in line 10) is recycled through lines 31 and 20 to the mixture entering mixer 21. When injected into the brine in settler 26 in the above fashion, precipitated calcium, magnesium, aluminum, etc. carbonates and hydroxides are settled out in the bottom of the settler as a fine slurry and are discarded from the system through brine discard outlet 30. The brine which is recycled by line 31 is therefore practically free of such precipitates.

High Efficiency Lubricants

ARSENIC COMPOUNDS are employed as the base for a series of heavy duty lubricants described by Standard Oil Co. (Ind.) in its U. S. patent 2,439,819. One example given involves heating neutral degras with about 20% phosphorus pentasulfide at about 300°F. for an hour. The sludge is separated, this being largely phosphorus pentoxide, and the product, substantially free of phosphorus, is then reacted with about 5% of arsenic trioxide at about 250°F. for an hour. About 1% of the clear product is added to an SAE 20 midcontinent lubricating oil which is tested in an engine at full load, running on high octane fuel.

After 100 hrs. of running, the sludge in the oil was 0.8%, acid number of the oil was 1.4%, and viscosity increase was 182, while the piston was entirely free from lacquer. On the other hand, an undoped SAE

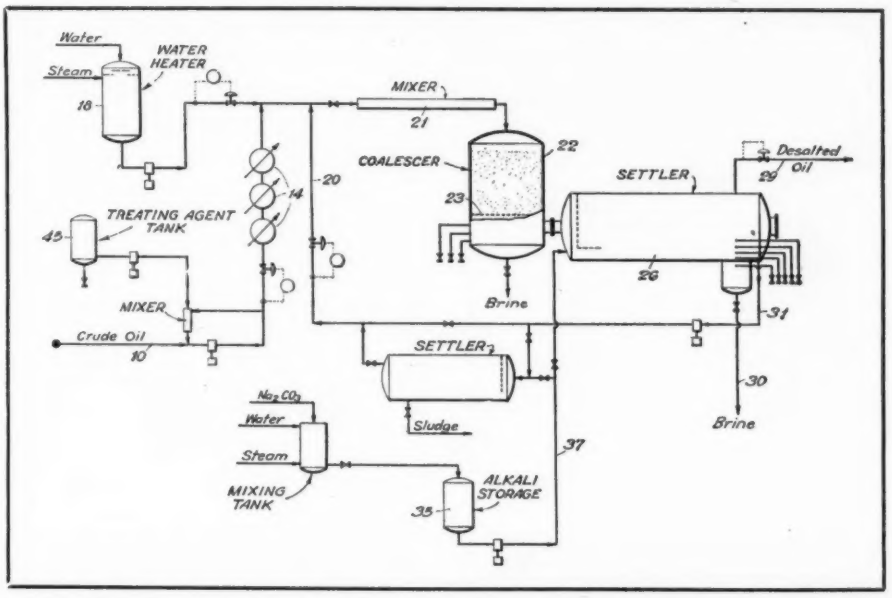

Fig. 1—Flow diagram of Indiana Standard's crude desalting process and method for preventing the formation of precipitates while adding caustic soda to control pH (U. S. 2,440,617)

20 oil of this type, after running only 20 hours, showed 4% sludge, acid number 2.0, viscosity increase 413, and lacquer deposit on the piston amounting to 80 mg.

Selected Patents

U. S. PATENTS issued from April 27-May 18

U.S. 2,440,671 (Phillips Petr.)—Hydrogenation of butadienesulfones to thiophenes.

U.S. 2,440,673 (SOD)—Utilizing fuel gas in refining petroleum fraction.*

U.S. 2,440,743 and 56 (Filtrol)—Promoted acid treated clay catalyst.

U.S. 2,440,750 (SOD) — Polymerization catalysts.

U.S. 2,440,808 (Rohm & Haas)—Suspension polymerization.

U.S. 2,440,822 (Phillips Petr.) — Conducting catalytic reactions.

U.S. 2,441,142 (Pure Oil)—Cracking in presence of Br compound.

U.S. 2,441,170 (Houdry Process)—Hydrocarbon catalytic conversion.

U.S. 2,441,214 (U.O.P.)—Conversion catalyst using siloxane.**

U.S. 2,441,240 (Pure Oil)—Cracking in presence of terpenes plus bromine compounds.

U.S. 2,441,249 (Ocon et al)—Alkylation

U.S. 2,441,258 (Tide Water Assoc. Oil)—Removing oil from sulfonates with nitroparaffin.

U.S. 2,441,295 (Gulf Oil)—Oil soluble dialkyl phosphoric acids.

U.S. 2,441,297 (Union Oil)—Aromatization of hydrocarbons.

U.S. 2,441,311 (Socony)—Contacting gases and particles from solid material.

U.S. 2,441,331 (Socony)—E.P. lubricant.

U.S. 2,441,386 (Union Oil)—Educting oil from shale.

U.S. 2,441,385 (Pure Oil)—Mercaptan recovery.

U.S. 2,441,479 (Union Oil) — Apparatus for cataphoretically treating a liquid suspension.

U.S. 2,441,493 (Atlantic Refg.)—Desulfurizing hydrocarbons with boron phosphate-alumina catalyst.

U.S. 2,441,496 (Continental Oil)—Stabilized oil.

U.S. 2,441,572 (Sun Oil)—Separating aromatic hydrocarbons with silica gel.

U.S. 2,441,587 (S.O. Ohio)—E.P. lubricant.

U.S. 2,441,663 (U.O.P.)—Purifying saturated hydrocarbons involving selective demethylation.

U.S. 2,441,666 (S.O.D.) — Powdered catalyst process.

U.S. 2,441,720 (Socony) — Bleeding-resistant soda grease.

U.S. 2,441,724 (Socony)—Operations with contact mass.

U.S. 2,441,827 (Union Oil)—Extraction.

FOREIGN PATENTS (and Applications)

Austral. Appl. 17,870/48 (Texaco Dev.)—Fractional separation of fatty oils.

Can. 447,053 (Shell Dev.)—Mercaptan extraction.

Can. 447,054 (Sinclair Refg.)—Improving film strength of lubricants.

Can. 447,055 (Sinclair Refg.)—Decolorizing oil with clays.

Can. 447,060 (Union Oil)—Lube oil containing mixed soluble green and mahogany soaps.

Can. 447,066 (Dunstan et al)—Alkylated aviation fuel.

Can. 447,074 (Barrer) — Crystalline molecular sieve adsorbents.

Can. 447,601 (SOD)—Catalytic reaction

Can. 447,602 (SOD)—Apparatus for short reaction time.

Can. 447,605 (Univ. Oil Prods.)—Alkylation.

Can. 447,606-7 (Univ. Oil Prods.)—Isomerization.

Can. 447,835 (Int. Lubricant Corp.)—Pb soap of hydroxystearic acid in grease.

Can. 447,852 (Shell Dev.)—Isomerization.

Can. 447,853 (Shell Dev.)—Cyclohexane from petroleum.

Can. 447,863 (Univ. Oil Prods.)—Isomerization-alkylation.

Brit. Appl. 33164/47 (Shell)—Treating olefinic aldehydes.

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Brit. Appl. 12967/44 (Texas)—Isomerization.

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Brit. Appl. 11,767/47 (Calif. Res. Corp.)—Injection engine fuel.

Brit. Appl. 11,568/47 (Houdry Process Corp.)—Contact masses.

Brit. Appl. 11,989/46 (Phillips Petr. Co.)—3-Methyl pyridine.

Brit. Appl. 10,711/47 (Texaco Dev. Corp.) — Thiophene compounds.

Brit. Appl. 834/48 (Anglo-Iranian Oil)—Desulfurization.

Brit. Appl. 535/48 (Shell)—Extractive crystallization.

Brit. Appl. 14577/47 (Calif. Res.)—Fluorinated olefin polymers.

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Brit. Appl. 34824/47 (S.O.D.) — Scavenging agent.

Brit. Appl. 15030/47 (Shell)—Polymers.

Brit. Appl. 15822/47 (Shell)—Reactivating spent absorbent.

Brit. Appl. 32720/47 (Shell)—Peroxidic compounds.

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Brit. Appl. 1262-3 (Sharples)—Soap.

Brit. Appl. 931/48 (Shell)—Compounded oil.

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Brit. Pat. 594,818 (Anglo-Iranian Oil Co.)—Olefin-polysulfide compositions.

Brit. Pat. 594,776 (Texaco Dev. Corp.)—Electric discharge devices.

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Brit. Pat. 594,982 (Stand. Oil Dev. Co.)—High temperature cracking.

Brit. Pat. 594,983 (Anglo-Iranian Oil Co.) — Aromatic hydrocarbons.

Brit. Pat. 593,989 (Stand. Oil Dev. Co.)—Vapor phase isomerization.

Brit. Pat. 593,418 (Stand. Oil Dev. Co.)—Cracking hydrocarbons.

Brit. Pat. 591,543 (Shell Dev. Corp.) — Ditertiary peroxides.

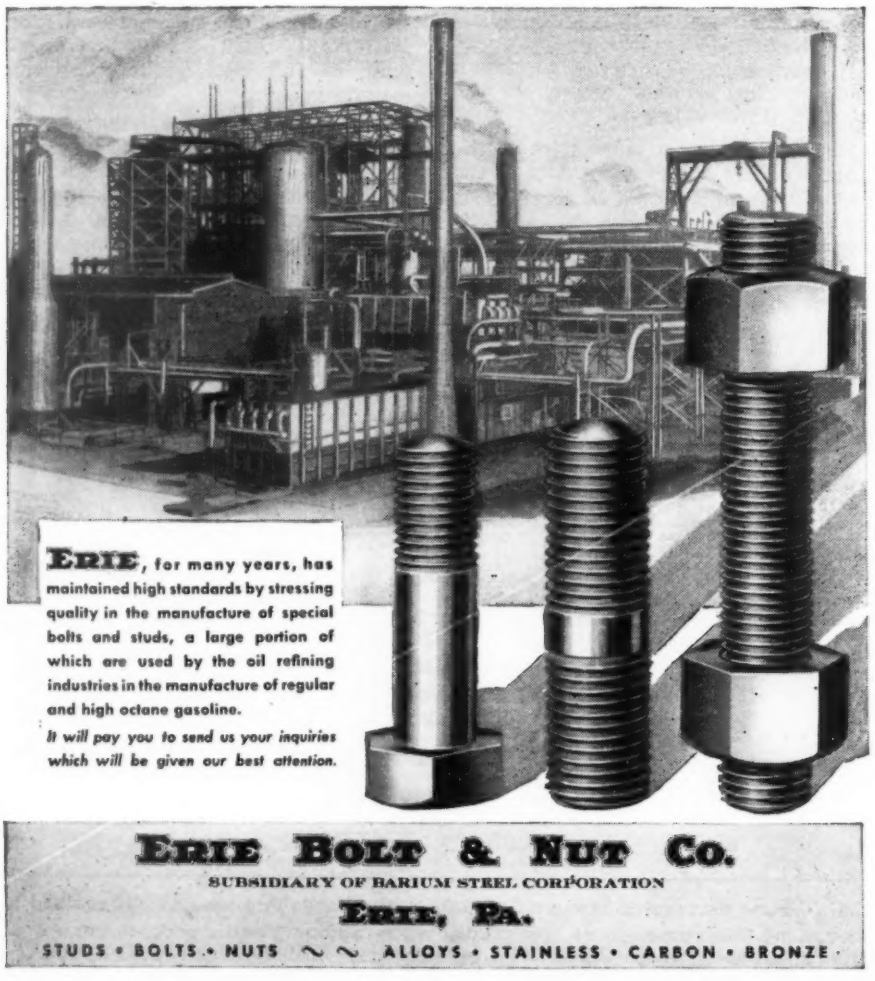
Brit. Pat. 591,631 (Univ. Oil Prods.)—Alkylation.

Brit. Pat. 591,544 (Stand. Oil Dev. Co.)—Alkylation.

Brit. Pat. 591,632 (Shell Dev. Corp.)—Halogen compounds.

Brit. Pat. 591,547 (Gulf Oil)—Dealkylation of alkyl phenols.

*SOD = Standard Oil Development.
**UOP=Universal Oil Products.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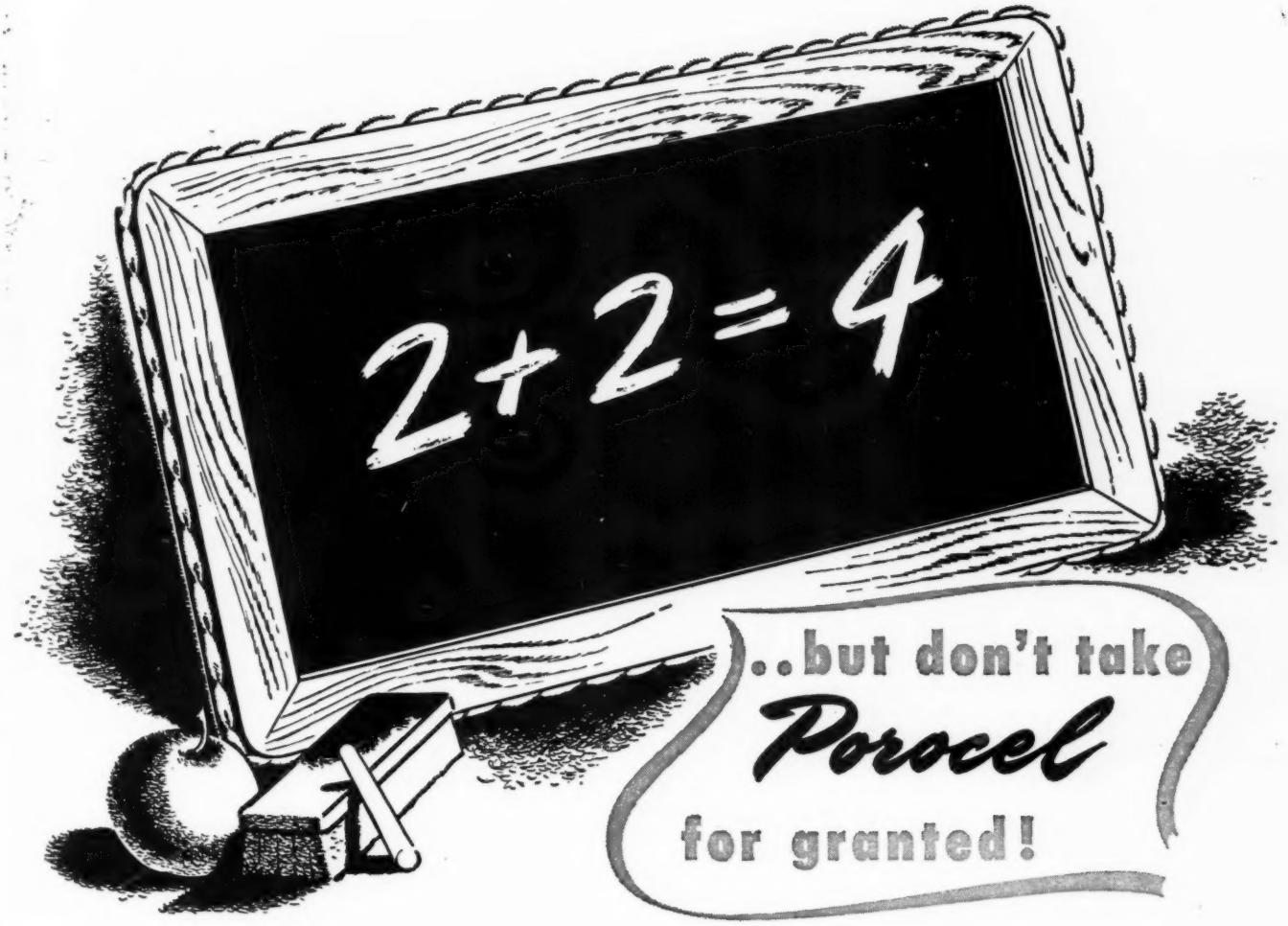

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Consider Porocel, for instance, in your expanding Chemical Products plans. It's likely there's a multitude of scrubbing operations where, during the course of making petro-chemicals, other materials introduced must have their last traces removed in order to gain complete stability. These are jobs for Porocel with its large and highly active surface area and its chemical inertness. And Porocel's doing these tasks every day with sulfur, acids, fluorides and other impurities.

Or, as a special reforming catalyst, Porocel can be the answer to some of the complications encountered in present-day manufacture of petro-chemical products.

We've perfected many intricate pre-treatments required to alter Porocel for specific adsorption and catalytic duty. Our sources and facilities insure prompt supply of uniform material. And, we'd welcome the chance to help *you* cut costs and improve products—with "engineered" Porocel. Address: Attapulgus Clay Company (Exclusive Sales Agent) Dept. D, 210 West Washington Square, Philadelphia 5, Pa.

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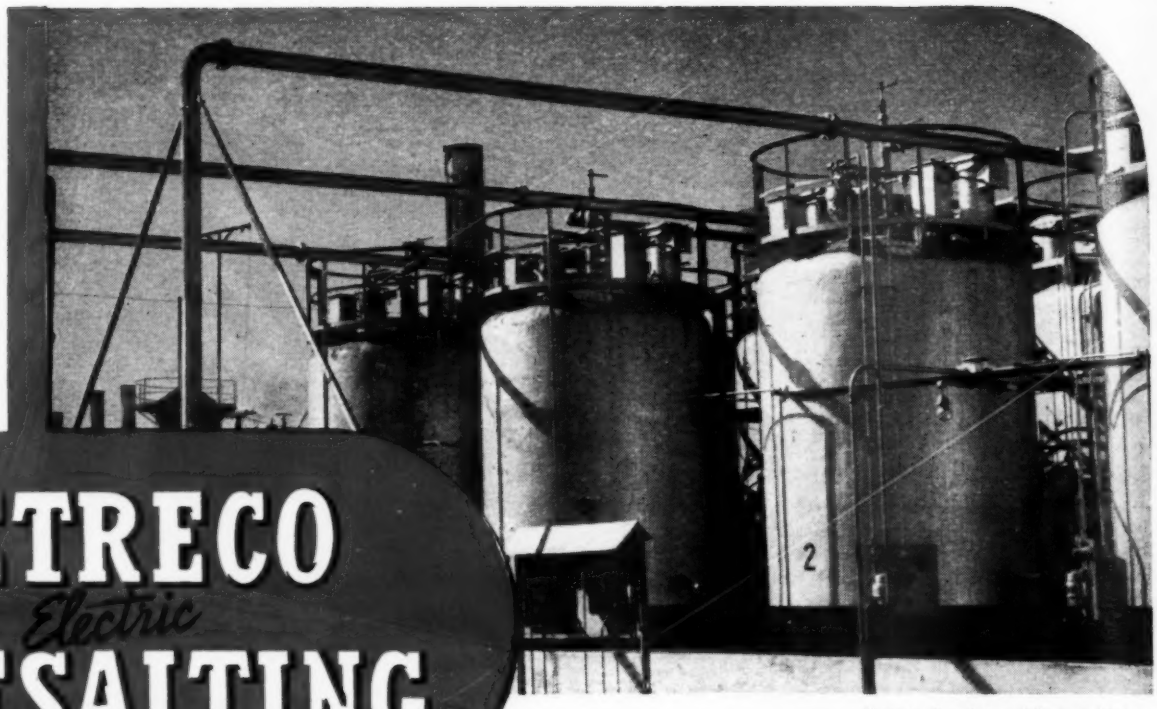

PETRECO *Electric* DESALTING

Photo by Permission of Sunray Oil Corp.

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Petreco Electric Desalting increases refining capacity. It keeps refining equipment on stream by preventing shutdowns caused by salt plugging, severe corrosion and hard coke formation.

Petreco Electric Desalting prevents salt plugging and hard coking. It retards corrosion caused by evolved HCl. It eliminates many impurities which are major causes of equipment depreciation, metal losses and high replacement demands.

In the face of increasing demands for petroleum products, and the scarcity of steel required to build the refining units needed to provide greater capacities, it is absolutely necessary to get maximum efficiency from available equipment. This is exactly what Petreco Desalting is enabling many refiners to do; if you are charging salty crudes, we can help you, too.

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PR 48-1

Claim Vapor Loss Is Eliminated In Double-roof Storage Tank

USUAL SHORTCOMINGS of floating roof storage tanks are said to be eliminated in a double-roof design permitting the use of a fixed weather roof on the outside and a floating roof arrangement on the inside without danger of any explosive mixtures being formed beneath the weather roof.

Conventional floating roof tanks are somewhat bulky and occasionally expensive to build, it is said. Often the vapors gather in small areas and tend to get the float out of balance. There is also some danger of vapor leakage around the edge should the seal become worn. The new tank design is shown in Fig. 1.

A weather roof 11 is supported on posts on shell 10. Depending skirt 12 on the outer rim of roof 11 serves as a shield to prevent snow, rain, dirt, and the like from blowing in through screen 19. Floating roof 13 has a flat bottom and an upstanding edge flange 20. Flexible sealing member 14, which may be a fabric impregnated with a flexible impervious material, is attached to the edge of roof 13 and is also in sealing contact with the bottom 15 of the tank. It is substantially cylindrical in shape and its length is sufficient to provide the maximum storage space desired.

The balance of the tank comprises an inlet and outlet pipe 24 for the volatile liquid to be stored in space 22, and a sealing liquid split into two portions: 16 between sealing member 14 and shell 10; and 17 over the bottom 15 and within sealing member 14. This liquid is of greater specific gravity than the liquid to be stored. Means are provided for connecting the two portions 16 and 17; as for example, the bypass pipe 23 shown in the drawing.

Pipe 24 extends upwardly inside so that it reaches a point above the highest possible level of the portion 17. As liquid is pumped into space 22, roof 13 rises and the quantity of sealing liquid in portion 17 is decreased while that in portion 16 is increased. When stored liquid is withdrawn, the roof 13 will fall and conditions will be just the opposite.

At all times, a perfect seal is provided which keeps all vapors within space 22 and beneath the floating roof 13. No pontoons, reinforcing trusses, or drains are required. Because there is no abrasion on the inside of the shell, this surface may be kept painted so that rust will not form and drop to the bottom to clog the pumps.

U. S. 2,439,792, issued April 20, 1948, to Harry C. Boardman, assignor to Chicago Bridge & Iron Co.

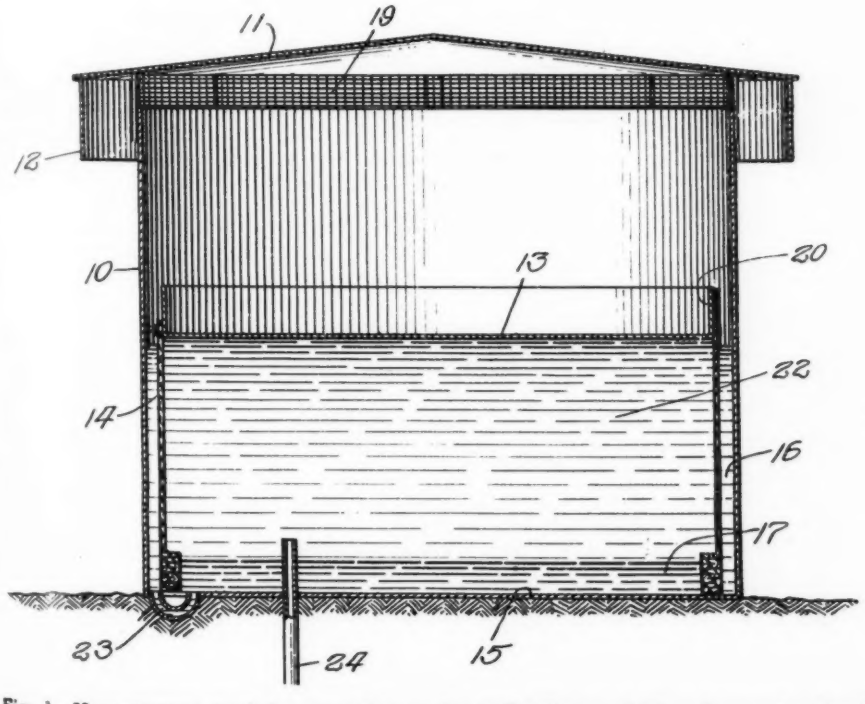

Fig. 1—New storage tank incorporates an inner floating roof 13 and an outer fixed roof 11 (U. S. 2,439,792)

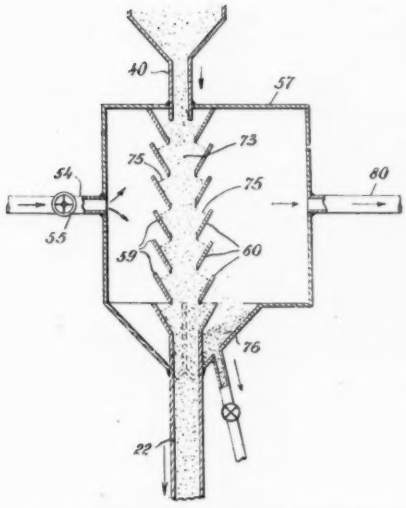

Fig. 2—Purge vapor flow across louvres 75 entrains undersized catalyst particles (U. S. 2,441,724)

Device Stops Interruptions by Undersized Catalyst Particles

IN A MOVING BED (TCC type) catalytic cracking unit, interruptions in the flow of catalyst particles through the vertical pipe from hopper to converter have been found to be caused by gradual accumulations of undersized catalyst particles in the upper section of the feed leg.

A recently patented device which can be installed in the upper section of the fed leg just below the hopper serves to remove this undesirable excess accumulation, it is said. One embodiment is shown in Fig. 2.

In operation, catalyst particles flow downwardly from the hopper through pipe section 40, through the particle disengaging device and down the feed leg 22. Disengager 73 consists essentially of a pair of louvred walls comprising baffles 59 and 60 and the corresponding slotted openings 75.

The upward or countercurrent, flow of purge gas introduced in the converter below passes through line 22 into disengaging section 73 and out slots 75. It carries with it, by entrainment, the small unwanted particles from the catalyst column. In addition, purge vapor introduced through line 54 can be controlled by valve 55, whence it passes horizontally across the chamber 57 and out line 80. This vapor also entrains undersized particles, all of which are deposited in conical receptacle 76 and withdrawn as required.

The required rate of flow of purge gas through valve 54 varies for each application. Experimental work has shown that for an ordinary granular clay type catalyst of an apparent unpacked density of about 37 lbs./cu. ft., the linear velocity of atmospheric pressure air at 80° F. required to en-

train particles of 0.10 and 0.02 in. diameter was about 30 and 6 ft./sec. respectively.

U. S. 2,441,724, issued May 18, 1948, to Thomas P. Simpson, assignor to Socony-Vacuum Oil Co., Inc.

Obtain Flow-ratio of Two Fluids Using Double Rotameter Tube

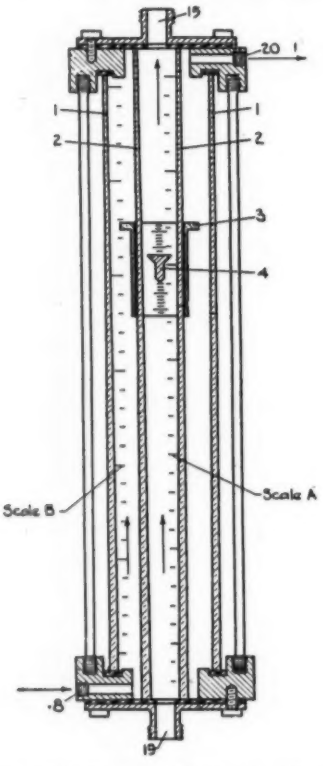

Fig. 3—Relative positions of rotameter floats 3 and 4 indicate flow-ratio of two fluids (U. S. 2,439,614)

TWO ROTAMETER type flow meters are combined in parallel in a single instrument useful for measuring fuel-air ratio in aircraft engines, or for automotive road and stationary laboratory test engines. Properly calibrated, the device can be used for measuring relative flow rates of any two fluids: gas-gas, gas-liquid, or liquid-liquid, as for example in the operational control of refineries and chemical plants.

As shown in cross section in Fig. 3, it consists of two concentric, conventionally-tapered, rotameter tubes —an inner tube 2 and an outer tube 1. A rotameter float 3, of a design which minimizes greatly density and viscosity effects, is constructed of some transparent material so that a scale can be marked on its surface.

Float 3 is hollow and slides up and down on the outer surface of tube 2. An inner float 4, of similar design in shape and preferably opaque or translucent, flows up and down inside tube 2.

In operation, one of the two fluids whose flow ratio is being measured passes through inlet 8, annular space between tubes 1 and 2, and out via 20; its flow being effective on float 3. The other fluid enters at 19, passes up through the inside of tube 2 and out via 15; its flow being effective on float 4.

For metering purposes, the scale on transparent float 3 is calibrated in terms of the flow ratio of the two specific fluids being handled. Scales A and B on tubes 1 and 2 are calibrated in the actual flow rates of each fluid.

U. S. 2,439,614, issued April 13, 1948, to Milton E. Schramm, assignor to Shell Development Co., San Francisco, Calif.

Bomb Safety Factor Improved By Inclining Closure Screws

A GREATER FACTOR of safety in the construction of a closure for high-pressure—over 10,000 psi.—chemical reaction bombs is provided by placing the cap screws at an angle as shown in Fig. 4. In addition, the connections in the center of the closure head are made more readily accessible, it is said.

As an example; in the conventional design for closures of this type, a seven-inch compression head might be secured in position by sixteen ¾-in. cap screws. In the construction indicated in the drawing, only twelve 1½-in. cap screws might be arranged in the same space occupied by the 16 smaller ones, because of the angular position.

In the drawing, two of the twelve screws, 66 and 72, have been inclined at about 20° from the vertical, but the patent does not restrict as to the specific angle required.

U. S. 2,438,513, issued March 30, 1948, to Douglas P. Meigs, assignor, by mesne assignments, to American Instrument Co., Inc.

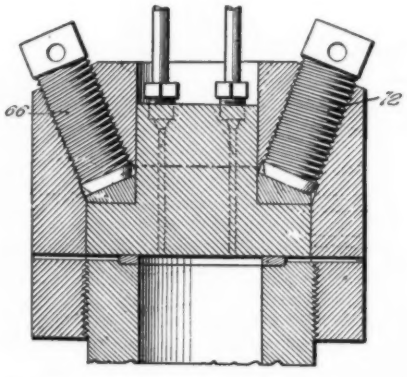

Fig. 4—High pressure reaction bomb closure using inclined cap screws (U. S. 2,438,513)

Improve Accuracy in Slide Rule Through Use of Traveling Tape

GREATER DEGREE of accuracy for a larger number of significant digits is reported obtainable in a slide rule provided with traveling tapes in place of the usual sliding scale.

The tapes have their ends wound on reels at each end of the rule and have scale graduations spread apart to facilitate easier and infinitely more exact readings. The width of the spread of the graduations is determined by the respective lengths of the tapes used.

U. S. 2,439,025, issued April 6, 1948, to Gordon W. Sammons, Hagerstown, Md.

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with greatest interest:

Rotameter Metering Tube in which the conventional center guide wire has been eliminated, using instead, three evenly-spaced glass ribs around the inside walls of the tube, and said to reduce tendency of the float to stick. U. S. 2,441,350, issued May 11, 1948, to Kermit Fischer, assignor to Fischer & Porter Co., Hatboro, Penna.

Pump for Corrosive Liquids of centrifugal type in which non corrosion-resistant rotor shaft is protected by sealing it off with a non-corrosive liquid and maintaining the sealing liquid at slightly higher than pump discharge pressure by means of separate auxiliary pump. U. S. 2,441,708, issued May 18, 1948, to E. L. Luaces and M. A. Crosby, assignors to Chemical Developments Corp., Dayton, O.

Continuous Oil Purifier uses most of the conventionally accepted methods for re-refining of lubricating oils and sets them up on a substantially automatic and continual basis; said to be more economical than batch procedure. U. S. 2,440,680, issued May 4, 1948, to F. L. Gerin, assignor to The Youngstown Miller Co., Belleville, N. J.

How to Obtain Patents

Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number from: The Commissioner of Patents, Washington 25, D. C.

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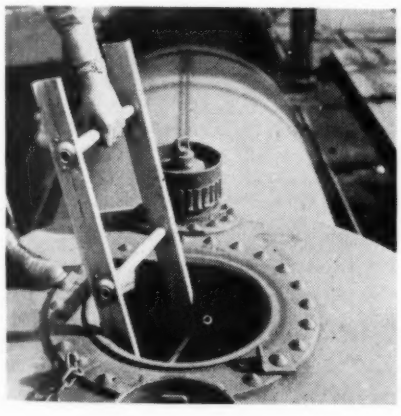
EQUIPMENT MATERIALS PROCESSES LITERATURE What's New!

Reviewed by WILLIAM C. UHL, Equipment Editor

1—Instrument Fittings

The "Flagg-Flow" line of threadless fittings now includes bronze as well as malleable iron, making possible one-piece brass, copper pipe or copper tubing. Said to be as strong as the pipe itself, the fittings are applicable for 150 psi. working steam pressure at 450° F., or 300 psi. non-shock cold water, oil, or gas lines, and will be adaptable for use on instrument lines, the manufacturer said. Stanley G. Flagg & Co.

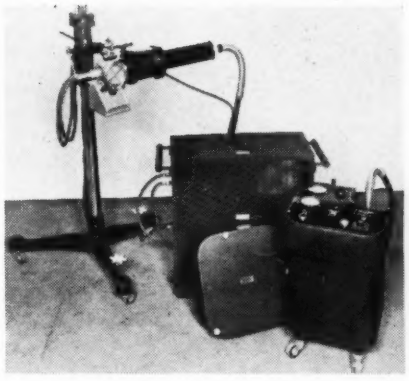


2—Light-weight Ladder

Strength, durability, resistance to fire, and non-sparking are said to be features of a new light-weight aluminum tank-car ladder. Of riveted construction and utilizing corrugated rungs, it has an outside width of 12 in. and weighs one lb./ft. It is available in any length through 16 ft. W. E. Brosius Co.

3—Tests Pressure Vessels

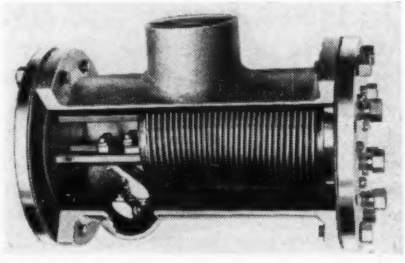
Residual stresses and the like in petroleum cracking towers and other pressure vessels may be measured by a new portable X-ray apparatus by means of a back-reflection. The instrument consists of a transformer and control unit, water pump for cooling the X-ray tube, flexible tube



stand, and X-ray tube with cobalt target to which is attached a specially-designed camera. The X-ray beam passes through the center of the camera, falling on the object to be investigated, and is back-reflected from the crystalline structure of the material to the circular film in the camera. Stresses are calculated from the lines in the X-ray pattern thus formed. St. John X-Ray Laboratories.

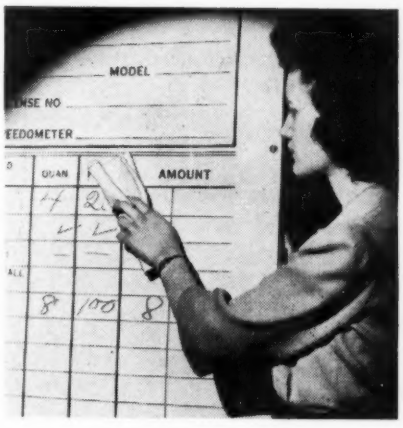
4—Corrosives Manometer

The new Taylor 18-8 Stainless Steel Aneroid Manometer is recommended for measuring and controlling flow, liquid level, or specific gravity in applications involving caustics or difficult acids such as sulfuric, acetic, nitric, and phosphoric. The housing and all internal parts coming in contact with the corrosion medium are made of Type 316 Stainless. The instrument is available in ranges of 20, 50, 100, and 200 in. of water differential with a body pressure rating of 300 psi. Taylor Instrument Cos.



5—Training Aid

Developed as a visual instruction aid for training sales and office personnel in the use of order books, forms, and the like, the new RCS "Eraso Print" is substantially a photographic "blackboard". It might easily be adapted for training programs in processing plants as a visual demonstration of flow diagrams, processing units, valves, control mechanisms, and so on. It consists of a giant "blow-up" of a photograph which is then coated with a material that permits writing or drawing on the enlargement with a colored pencil. These marks can be erased quickly with an ordinary rough, dry cloth. Rapid Copy Service.

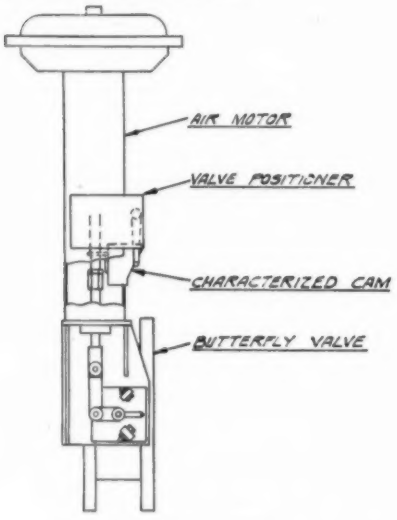


6—Lube Oil Additive

"Santolube 222" is a new magnesium type detergent-dispersant for compounding premium and heavy-duty lubricating oils. The new additive is said to impart a high degree of detergency at a relatively low concentration. In suitable base oils, Santolube 222 at 1.9%-vol. with Santolube oxidation inhibitor 394-C at 0.66%-vol. is reported to meet U. S. Army Specification 2-104B. Monsanto Chemical Co.

More "What's New!" Items, p. 698

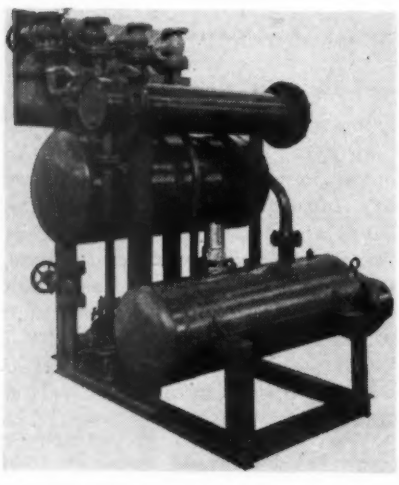
7—Valve Positioner



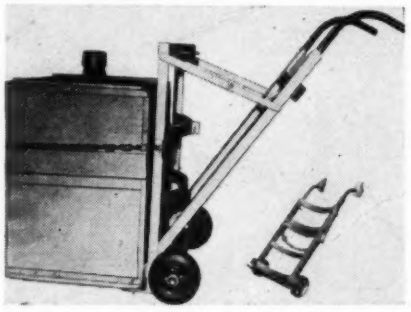
A cam-operated positioner is a feature of a new diaphragm motor valve of the disc or butterfly type. Control of flow characteristics is attainable in the field by changing cams on the positioner, in effect adding to the normal functions of this type valve. Characteristics within the range of the device are straight-line, semi-log curve, ratio plug valve, throttle plug valve, linear, and the like. R-S Products Corp.

8—Dowtherm Unit

Production has been started on a line of portable, self-contained Dowtherm heating and cooling systems. The system consists of one 100,000 Btu. per hour, electro-vapor generator; one 100-gal. Dowtherm surge tank; one 50 sq. ft. Dowtherm cooler; one cooling pump for circulation of the liquid Dowtherm; one complete charge of Dowtherm "A" heat transfer fluid; and the instrumentation and framework with control panel. During the heating cycle, the fluid is vaporized by the action of a 30 kw. electric immersion heater with explosion-resistant terminal cover. Design working pressure for the vapor generator is 60 psi. Blaw-Knox Co.



9—Dual-purpose Truck



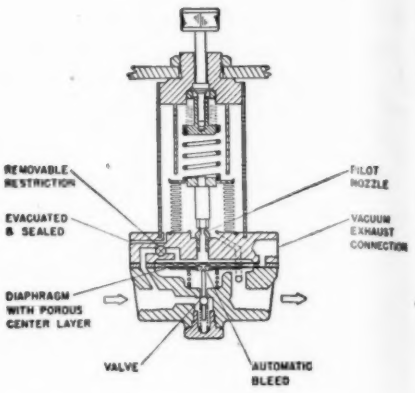
Two carrying positions on the lightweight, "Safety All-Purpose" Hand Truck adapt it to a variety of portage jobs. In the open position, it can be used to move carboys, acetylene tanks, drums, barrels, and other packages in a vertical position to avoid spilling the contents. In the closed position, it can be used for transporting packages in the conventional manner. The truck is of riveted, welded, and bolted construction, with tubular handles, and 6-in. aluminum wheels, or rubber tires. General Scientific Equpiment Co.

10—Self-locking Pliers

The "Lock-Line" self-locking plier will lock by normal hand pressure without adjustment by means of a cam action which also provides high cutting pressure for its use as a side wire cutter. Designed to lock on 11/16 in. between the deepest jaw serrations, it is made of drop-forged chrome vanadium steel with hardness rated at Rockwell RC 52-54. It has been tested to cut 19 strand No. 1 electric cable, 30-penny spikes, and ¼ in. annealed bolt stock or rod, the manufacturer states. Ross Mfg. Co.

11—Vacuum Regulator

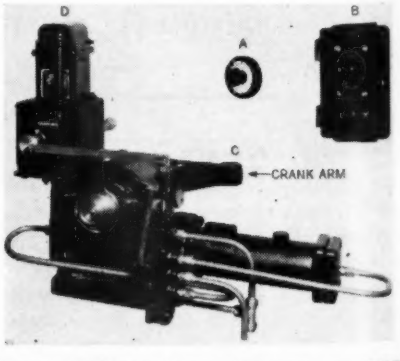
The line of "Nullmatic" Pressure Regulators for sub-atmospheric applications includes models with barometric compensation for control at Absolute values. They are designed to hold set values constant, regardless of changes in flow or supply pressure. They use the pneumatic "null"



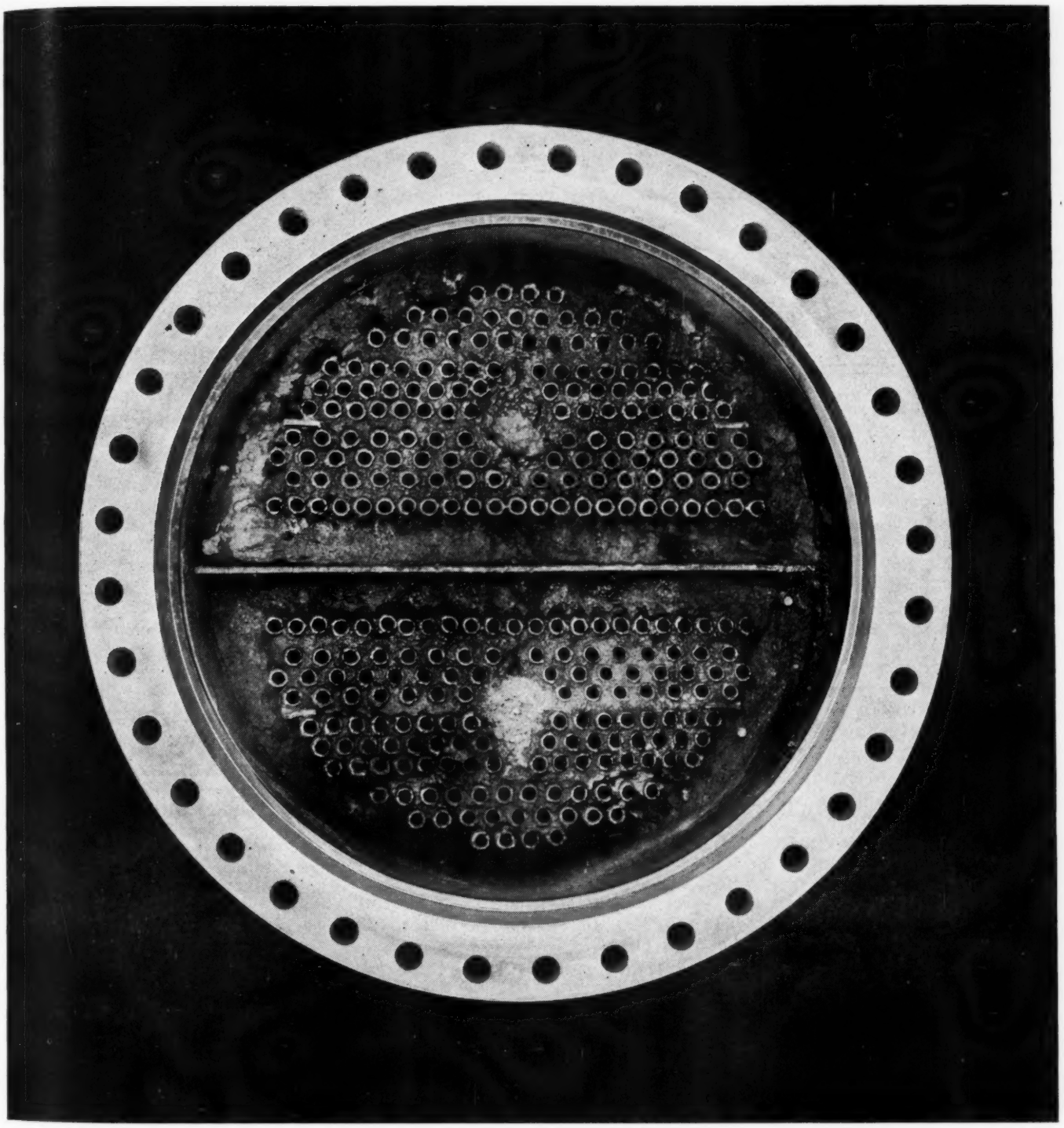
balance system in which the main valve is operated by a pilot nozzle, which operates with a constant differential-pressure that holds the nozzle seat at essentially the same position for each set value. Two models have an automatic bleed, making them suitable for dead-end service as well as flow or reverse-flow. Pressure range is 1 to 20 psia. on dead-end service, or approximately 0 to 20 psia. on continuous flow of 0.02 scfm. or more. Maximum capacity of all models is about 1 scfm. Moore Products Co.

12—Remote Control

An accurate, heavy-duty, hydraulic cylinder positioner is furnished in a new electronic remote control system. Cylinders with power output up to 7500 lbs. can be positioned at points 1000 ft. or more from the control station with an accuracy of cylinder movement of 0.1%, it is stated. In the system illustrated, the position of the cylinder crank arm can be selected at either control station A (remote transmitter) or station B (transmitter and amplifier). An electric signal of the position selected is transmitted to the receiver motor D which operates a pilot valve positioning the crank arm at any point within its 90° arc. Askania Regulator Co.



More "What's New!" Items, p. 700



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SHELL

SHELL DEVELOPMENT COMPANY
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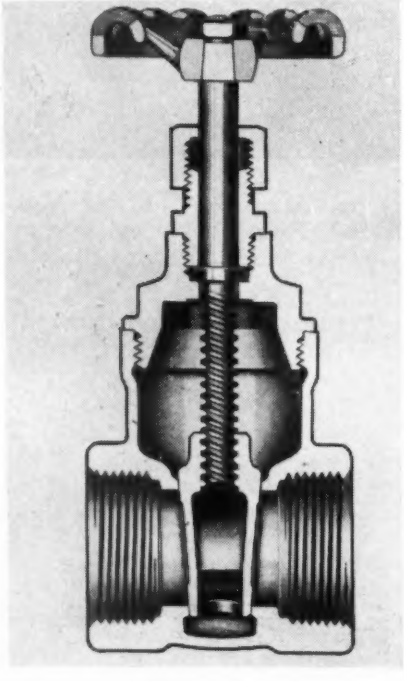
13—Laboratory Motor

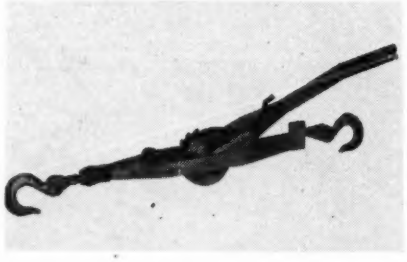
Designed to maintain constant maximum torque at all speeds, the Guernet Model T Variable Speed Motor gives step-less speed control from 1500 to 6000 rpm. Control is by a lever at the side of the motor. Measuring approximately 9 x 7 x 5 in., the unit is 1/5 hp., ball bearing, universal wound, reversible, 115 volts, single phase, any frequency. It is also available with single and double reduction gears, and with flexible shafts. Guernet Electrical Machinery, Inc.

14—Brass Gate Valves

The new line of Crane 100-lb. brass gate valves is intended to replace Crane Nos. 449½ and 1319, which are being discontinued. They are non-rising stem valves and are furnished in two types: No. 410, screwed-end, in sizes ¼ to 2-in.; and No. 1320, solder-joint, in sizes ⅜ to 2-in. The upper portion of the body is cylindrical, similar to design used previously only in steel valves for high pressures. This shape is said to reinforce the seats against the wedging action of the disc and safeguard against distortion when the valve is being seated. Valve seats are cast as part of the body. Stuffing box is packed with molded asbestos and can be repacked while under pressure in the wide-open position. Screwed valves are recommended for low pressure condensate lines, exhaust steam lines, and low pressure process steam lines. Solder-joint valves are suitable for same services but are not recommended for gas or fuel oil. Crane Co.



15—One-man Hoist



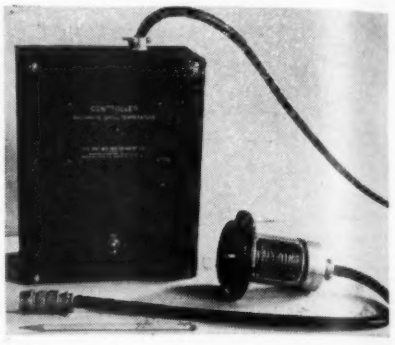
"Pow'r Pull" is a light-weight, one-man hoist for lifting, pulling, wire-stretching jobs, and the like. Weighing six lbs., it has a 1500-lb. capacity and has been tested to 50% overload. Manufacturer states it can be used on any job where a chain hoist or block and tackle are used, for both vertical and horizontal pulls. Can be furnished with various lengths of cable. American Gage & Manufacturing Co.

16—Burn Treatment

Safe, rapid, and effective treatment of minor burns is claimed for the new "R-52" Burn Ointment. Active ingredients are phenol, apiol, oil cinnamon, acetic acid, and lanolin. It is packed in 13 oz. net wt. jars for industrial users. Pharmaceutical Preparations, Inc.

17—Low-range Pyrometer

A new low-temperature radiation pyrometer is reported useful where the device does not or cannot come into contact with materials or processing equipment. The complete system includes the low-range "Radiamatic" head; a control box to control the temperature of the head, plus the reference junction of the temperature

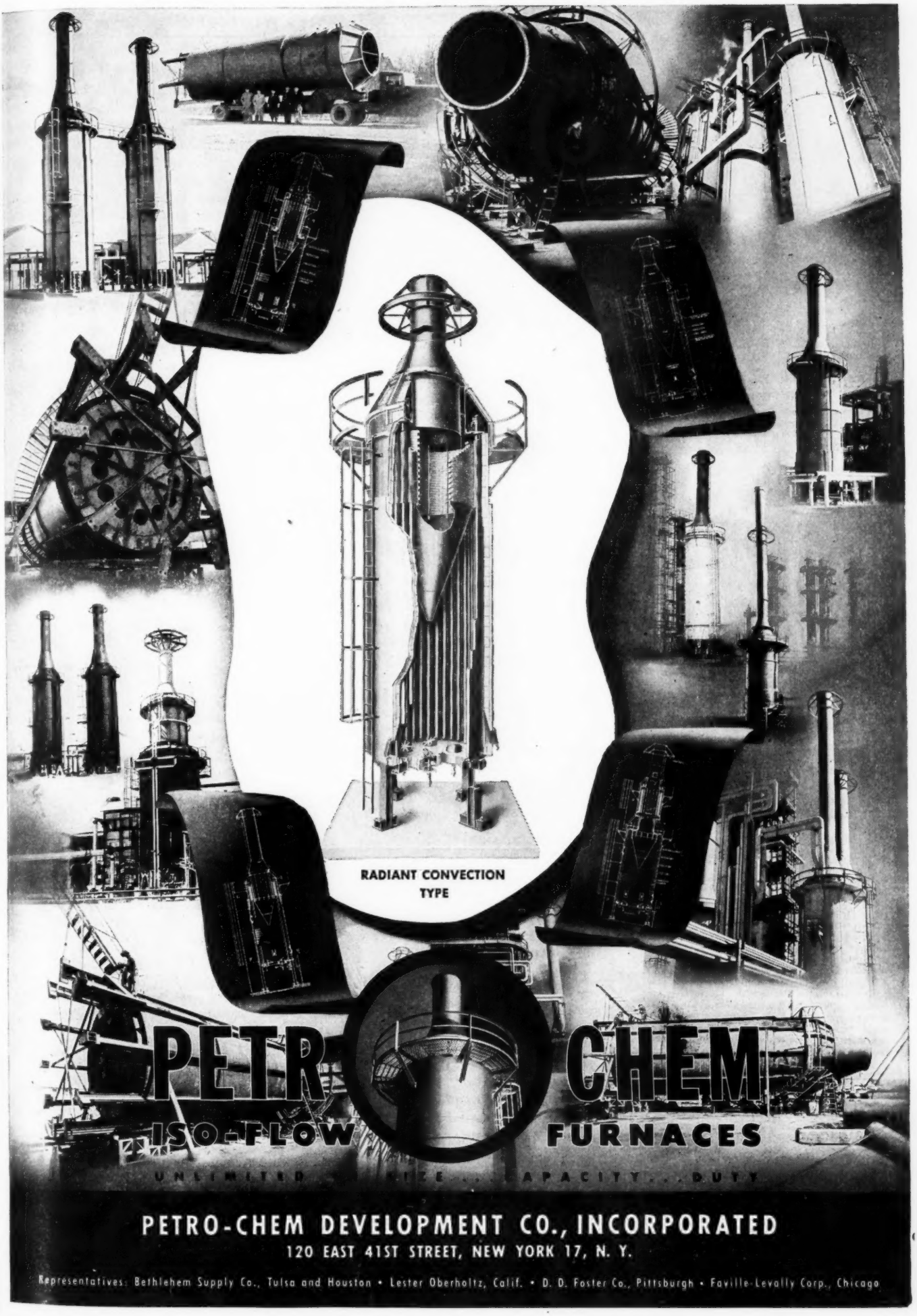


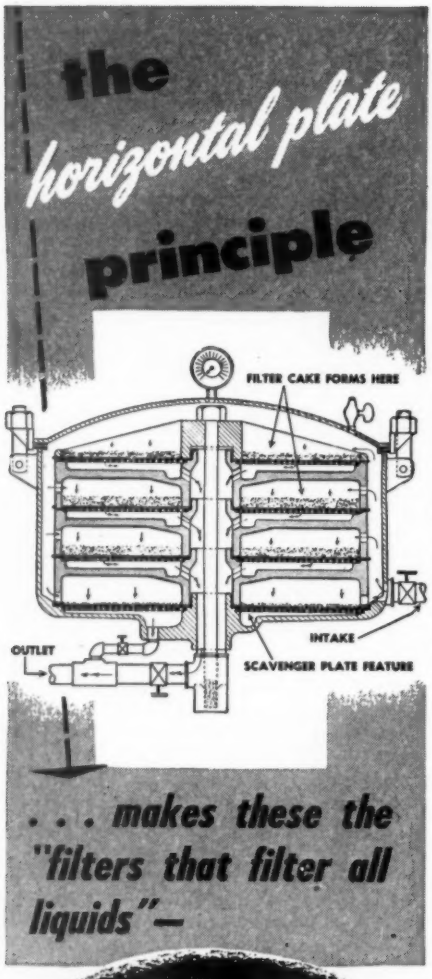
of the thermopile, at approximately 120°F., plus or minus one degree; and an electronic recorder, circular or strip chart model, with control features if desired. The system will respond to temperature changes of one or two degrees F. within the span of ambient temperature to 212°F. It is offered as an uncalibrated unit only, because any calibration would depend upon its use under black body conditions, or on a target of known emissivity. Ambient temperature surrounding the Radiamatic head should always be below 120° F. and not subject to rapid fluctuations. Full target area is 3-1/2-in. diameter circle at 12 in. from the lens. Brown Instrument Co.

18—Smooth-flow Pump

Non-pulsating flow is said to be a feature of a new line of positive displacement, helical rotor pumps. Two rotors, one a driver and the other an idler, forces the liquid ahead in axial flow. The drive shaft is mechanically sealed against leakage by a Syntron "Anti-Friction" Shaft Seal. Built in two sizes, the pumps are designed primarily for handling various grades of oils with reasonable lubricating properties, such as fuel oil, heavy crude, lubes, and hydraulic oils, at either 50 or 75 gpm. at pressures up to 125 psi. The suction port can be located in any position relative to the discharge port, and the pump can be either base or flange mounted. Pipe openings are 1½ or 2-in. Housings are 4¾ by 5-7/8 by 10½ or 12¼ in. for the two models. Syntron Co.

More "What's New!" Items, p. 702


RADIANT CONVECTION TYPE
PETRO CHEM
ISO-FLOW FURNACES
UNLIMITED ... SIZE ... CAPACITY ... DUTY
PETRO-CHEM DEVELOPMENT CO., INCORPORATED
120 EAST 41ST STREET, NEW YORK 17, N. Y.
Representatives: Bethlehem Supply Co., Tulsa and Houston • Lester Oberholtz, Calif. • D. D. Foster Co., Pittsburgh • Faville-Levally Corp., Chicago


the horizontal plate principle
FILTER CAKE FORMS HERE
OUTLET
INTAKE
SCAVENGER PLATE FEATURE
. . . makes these the "filters that filter all liquids"—

SPARKLER
Horizontal Plate
FILTERS

. . . and here's the story:

- Sparkler Horizontal Plate Filters handle any liquid from heavy varnishes to light alcohols, including products such as acids, oils, beverages, milk, pharmaceuticals, plating solutions, water, etc.
- Equally efficient performance on intermittent or continuous operation, under a wide range of temperature, pressure and viscosity conditions.
- Equally effective whether removing carbons and contact clays or clarifying and polishing with filter aids.
- Patented Scavenger Plate permits complete batch filtration. (It's virtually an auxiliary filter with an independent control valve.)
- Unexcelled filter cake stability—no slipping or breaking.

. . . why?

Because filter media are supported on a horizontal plane and filter aids floated into position uniformly, filtration takes place uniformly over entire filtering areas. Flow through filter is always *with* gravity.
Sparkler Filtration Is *Engineered* Filtration—we invite correspondence on your problem. You will receive the advice of filtration scientists with a quarter of a century of experience in a specific field.

SPARKLER MANUFACTURING CO.
MUNDELEIN, ILLINOIS

19—Electronic Control

A new electronic temperature controller uses a single electronic tube with an electrical resistance type bulb for thermal pick up and is of the on-off type. It permits location of the sensing element at a point remote from the control panel and eliminates the need for thermal compensation. Units are available to cover the range from —100 to 1200°F. and are adjustable within a range of several hundred degrees. Supply voltage may be 115 or 230, 50-60 cycle alternating current. Load capacity is 30 amps. at 115 volts, 20 amps. at 230 volts. Accuracy is independent of usual voltage variations. Normal response time is under three seconds. A 5 by 5 by 10 in. control panel, weighing less than 8 lb., is furnished provided with conduit knockouts and a terminal board. Thomas A. Edison, Inc.

Trade Literature

20—Pilot Plants

On Pilot Plants and the Synthesizing Process Pilot Plant, a booklet describing the function and importance of pilot plants in the chemical process industries, and the operation of the Patterson Synthesizing Process Pilot Plant, which is built to ASME codes for working pressures from full vacuum to 100 psi., and is suitable for temperatures from 100 to 750° F. Patterson Foundry & Machine Co.

21—Mechanical Seal

The Stuffing Box, No. 50, April, 1948, includes information on "Dura Seal Type P.S.," a rotary mechanical sealing that can be depended upon to seal hydrocarbons up to 600 psi., it is said. Durametallic Corp.

22—Glass Bubble Columns

Glenlab, Form 2G448FC4, describes four standard sizes of "Oldershaw" Fractionating Bubble-Plate Columns of glass for laboratory and pilot plant uses; contains tabular data of maximum throughput, plate efficiency, operating and residual holdup, heat loss, and many other physical factors. Glass Engineering Laboratories.

23—Pressure Vessels

Wickes Facilities, Bulletin 44-4, 18-page booklet dealing with manufacturing processes involved in making ASME pressure vessels, boilers, and various steel structures. Wickes Boiler Co.

24—Automatic Controller

Auto-Selector Controller, Bulletin 421, presents a new instrument designed to provide automatic control of two related variables in a process by positioning a single valve; for example, flow through a heat exchanger by inlet pressure and cooled fluid outlet temperature. Foxboro Co.

25—Heat Exchangers

Western Supply Co.'s new booklet on the company's heat exchanger line includes a table for estimating prices of floating head exchangers on the basis of material of construction, capacity, etc., and also formulae for calculating shell side film coefficients. Western Supply Co.

26—Automatic Feed System

Controlled Volume Chemical Pumps, Design and Operation, Technical Paper No. 57, a reprint from *Chemical Engineering Progress,* April, 1948, issue, of an article on "Constametric" controlled volume pumps. Milton Roy Co.

27—Chemical Additive

Technigram, Industrial Edition, May 12, 1948, describes TERVAN 2800, a new blend of refined paraffin wax and VISTANEX (polyisobutylene), for imparting improved viscosity, adhesion, water- and water-vapor impermeability to asphalt compounds, paper coatings, rubber, textiles, and waxes. Esso Standard Oil Co.

28—Instruments

Instrumentation, Vol. 3, No. 3, contains a description of the instrument arrangement at Roosevelt Oil Co.'s typical, smaller than 10,000 b/d refinery at Mt. Pleasant, Mich., another article on use of automatic control of an LPG mixing system: and a discussion of techniques for measuring liquid level in vessels under pressure. Brown Instrument Co.

29—Insulation

Kaylo Heat Insulating Block for Temperatures up to 1200° F., is described in this new four-page folder giving a table of physical characteristics, standard sizes available, and charts on heat loss and efficiencies. American Structural Products Co.

30—Castings Repair

Tempil Topics, Vol. 3, No. 6, discussed methods for repairing castings by welding. Tempil Corp.

More "Whats New!" Items, p. 704

Powell LPG* Valves

FOR HANDLING BUTANE AND PROPANE GASES

*Liquefied Petroleum Gases

Fig. 8375—Bronze L. P. G. Gate Valve. Screwed ends, union bonnet and double wedge.

Fig. 8151—Bronze L. P. G. Angle Valve. Screwed ends, union bonnet and special composition disc.

Fig. 8150—Bronze L. P. G. Globe Valve. Screwed ends, union bonnet and special composition disc.

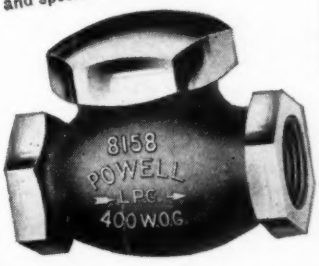


Fig. 8158—Bronze L. P. G. Horizontal Lift Check Valve. Screwed ends, screwed-on cap and special composition disc.

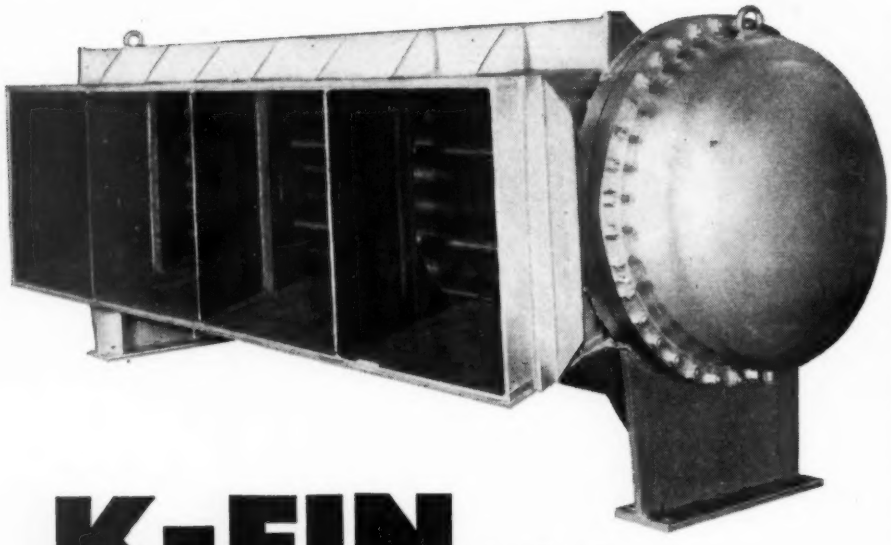
To meet the already large and ever-increasing use of "bottled gases," Powell offers a line of valves especially designed and ruggedly built to handle liquefied petroleum gases satisfactorily and safely.

In Globe, Angle, and Check Valves, a special composition disc known for its high resistance to the action of L. P. Gases is fitted into a full depth disc holder, having a T-slot for attaching to the stem, and is securely held by a lock nut.

The deep stuffing box of these valves provides for more than ample special packing. A protruding gland, held in position by the stuffing box nut, compresses the packing to prevent leakage and affords an additional guide to the stem. A cut-off collar on the stem engages with a smooth face machined on the under side of the bonnet, and permits the valve to be repacked under pressure when wide open. All trim parts are quickly and easily renewable.

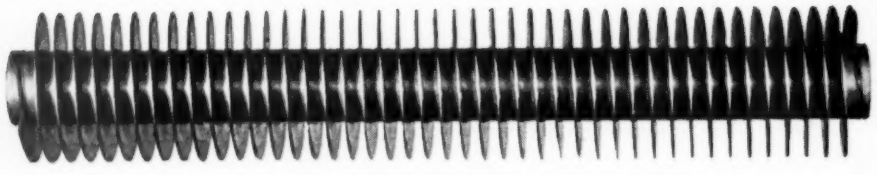
The Wm. Powell Company
Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES



K-FIN...

THE VAPOR HEAT EXCHANGER with 5 Exclusive Advantages



- **Lowest vapor pressure loss through the shell . . .**
- **Fewest tubes for a given duty . . .**
- **Least possibility of leakage . . .**
- **Rated capacity maintained for long periods without requiring tube cleaning . . .**
- **Speediest and easiest cleaning . . .**

These five features of the K-Fin Vapor Heat Exchanger warrant your further study of this unit for services such as transfer of heat between heavy oil vapor under vacuum and furnace charge.

Complete information is contained in our Bulletin 1626, copy of which will be sent on request.

THE GRISCOM-RUSSELL CO.
285 Madison Avenue New York 17, N. Y.

GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

What's New!

31—Weld Testing

Supersonic Reflectoscope, Sales Data Sheet 3021, a 6-page bulletin describing methods for testing welds in plate, thin sheet, and other sections and forms such as tubing, pipe, etc., in both ferrous and non-ferrous metals using a new supersonic inspection device. Sperry Products, Inc.

32—Reciprocating Pump

Data Sheets 62 *and* 67 describe various types and sizes of high pressure reciprocating pumps for refinery, pipeline and oil field service; includes pump dimension drawings, pump selection charts, and application photographs. Aldrich Pump Co.

33—Flow Measurement

Brooks Rotameter Catalog covers full line of rotameters for flow-rate measurement and control, including the new "Sho-Rate" for purge systems and the "Multi-Range" Flow Rate Kit for research laboratories and pilot plants; giving capacity charts, and dimension prints for each type. Brooks Rotameter Co.

34—Alloy Castings

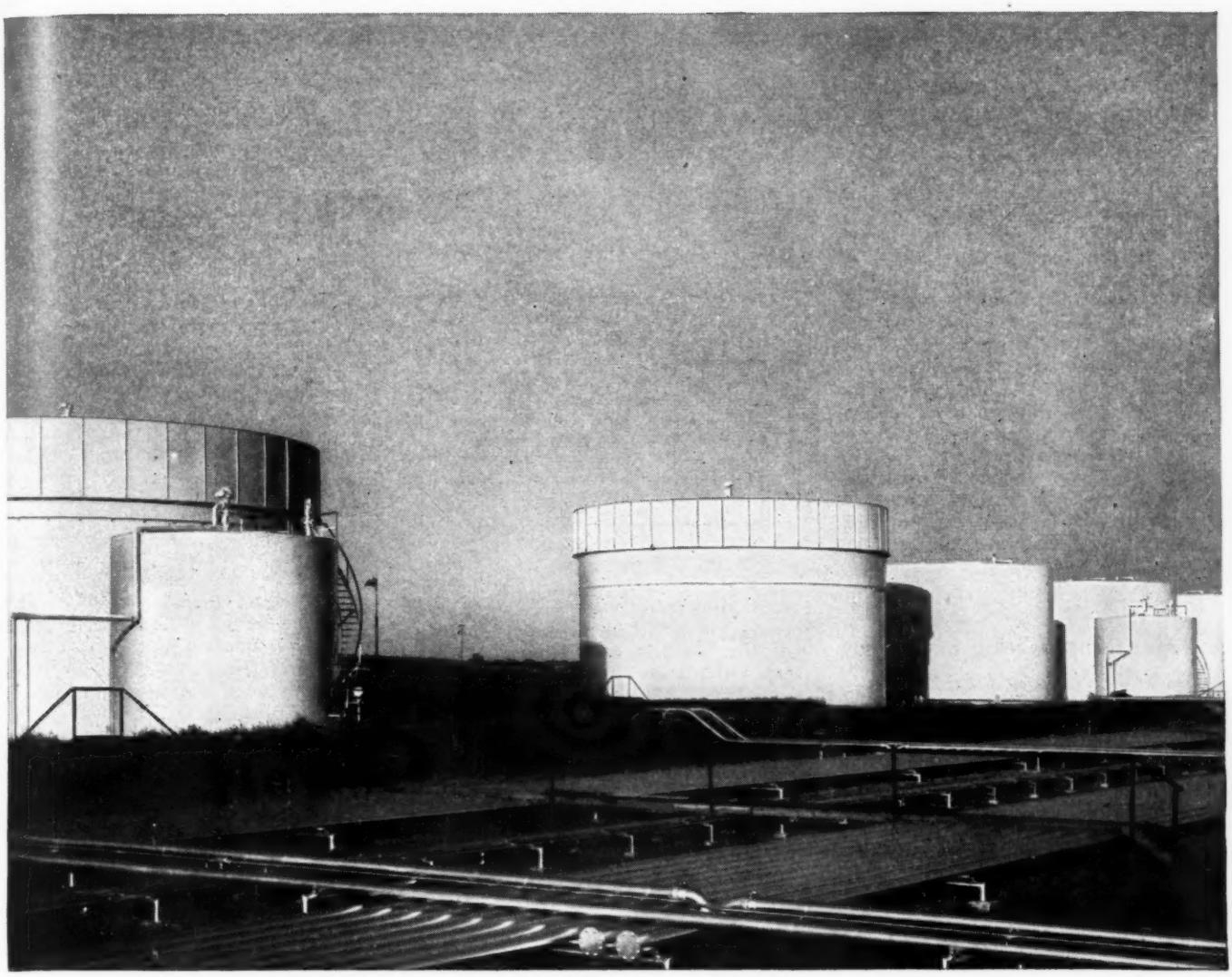
High Alloy Castings, Thermalloy and Chemalloy, Booklet T-155, describes a line of corrosion-resistant castings designed for protection at temperatures up to 2000° F. and capable of resisting the effects of rapid and repeated heating and cooling. Electro-Alloys Division, American Brake Shoe Co.

35—Power Cranes

"Lorains" in the Petroleum Industry from Production to Refinery, Form F-54512-8; a 16-page booklet illustrating applications for power cranes and shovels, shows such refinery uses as handling condensers and stills, building tanks, grading and diking tank farms, and general materials handling. Thew Shovel Co.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 697. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.



BALANCING ACT FOR HYDROCARBONS

When the volume pumped in exceeds the volume pumped out, there's danger of losing the most valuable part of your gasoline...the lighter fractions that mean superior performance in modern, high compression engines. The Expansion Roof Tank, either alone or manifolded to several cone roof tanks, acts as a balancing agent between the input and output rates and, in normal terminal operation, eliminates the possibility of filling losses.

This complete or near-complete elimination of filling losses is in addition to the absolute prevention of loss through standing or breathing. The Expansion Roof provides far more than the maximum volume required by vapor expansion due to temperature increases.

Available in a wide range of expansion capacities, the Expansion Roof is suited to most single or multiple tank storage facilities for production, refining, or marketing.

You'll find it profitable to investigate this balancing act for hydrocarbons when you plan increased storage equipment.

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

East Chicago, Indiana

Graver offers a complete service to the petroleum industry including Expansion Roof Tanks, Floating Roof Tanks and pressure vessels. In addition, Graver is prepared to furnish specialized steel plate work such as fractionating columns and class one vessels as well as stainless and alloy fabrication; water conditioning equipment of all types; and through the Graver Construction Co., is prepared to handle all types of petroleum and chemical construction work.

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ASTM Issues 1947 Index for Standard Specifications

Index to A.S.T.M. Standards, December, 1947, 5¾ x 8½ in., 256 pages, heavy paper binding.

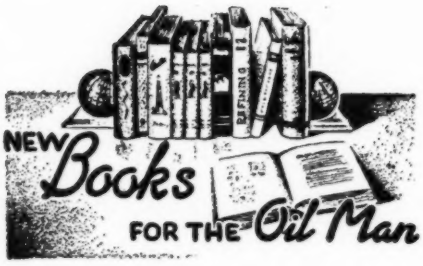
The December, 1947 edition of *Index to ASTM Standards* is an adjunct to the regular 1946 *Book of Standards* and the 1947 supplements, listing some 1500 standard specifications and tests for quick location. All items are listed under appropriate key-word definitions according to the subjects covered. As an added convenience, a list is also given of the standards in numerical sequence by their serial designations.

Copies of the publication will be furnished without charge on written request to the headquarters of the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Penna.

Chemical Engineering Economics Revised in New 3rd Edition

Chemical Engineering Economics, 3rd Ed., by Chaplin Tyler; 6 x 9 in., 330 pages, indexed, illustrated, stiff cloth binding, $4.00.

It is difficult to comment upon this new 3rd edition of *Chemical Engineering Economics* without using the trite phrase, "here is a book which



Copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third St., Cleveland 13, for the price listed, postpaid, unless indicated otherwise. Ohio purchasers please add 3% tax. U. S. Government publications should be ordered direct from the Superintendent of Documents, Washington, D. C.

is a must for the desk of any man concerned with the operation design or maintenance of a petroleum processing plant." The book is definitely that. Widely used since its original publication 22 years ago, and again after the 2nd edition in 1938, the present volume represents pretty much a complete revision. It includes meritorious contributions by 14 collaborating authors, experts in their respective fields.

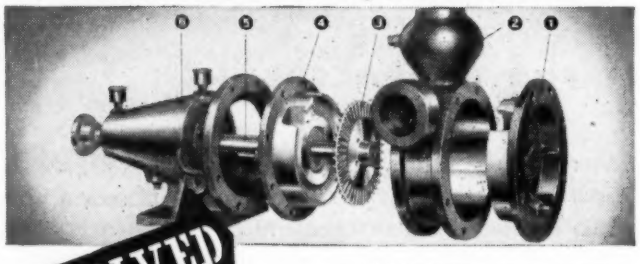
As in earlier editions, the subject matter has been divided into the various phases of chemical engineering, with chapters devoted to such topics as research and development, plant location and design, equipment costs, accounting methods, marketing, organization, patents, etc.

Author Tyler is a member of the Development Department, E. I. du Pont de Nemours & Co., and a lecturer in chemical engineering economics at the University of Delaware. Many of the collaborators are members of the du Pont organization, other leading chemical companies, or university faculties.

MCA Issues Methanol Safety Data

The Manufacturing Chemists' Association of the United States has issued a Chemical Safety Data Sheet, SD-22, on *Methanol, Properties, and Essential Information for Safe Handling and Use.* Included in the data, which were adopted for issuance May, 1948, is information on the properties, health and fire hazards, usual shipping containers, and data on handling with precautions, etc. Copies of the 16-page booklet may be obtained at 20c each by writing the Association at 608 Woodward Bldg., Washington 5, D. C.

PUMPING PROBLEMS*



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Look at these features:

1. Outboard head—easily removed.
2. Case—can be rotated to various positions.
3. Impeller—self adjusting, no seizing at high temperatures.
4. Inboard head — only one packing box.
5. Stainless steel shaft.
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Stainless steel heads, impeller, and case available.

*Whatever your pumping problem, consult Roth. Experienced engineers will recommend the equipment you need—will design special pumps for unusual applications.

Speeds up to 3600 RPM
Capacities up to 200 GPM
Pressures up to 175 lbs.
Viscosities up to 500 SSU

- Flexible coupled and close coupled pumps in stock.
- Motors up to 25 HP in stock.

Write for catalogs 1 & 2.

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ROTH PUMPS

MEETINGS . . . for the Oil Man

AUGUST

18-20, Society of Automotive Engineers, West Coast meeting, St. Francis Hotel, San Francisco.

30-Sept. 3, American Chemical Society, 114th national meeting, Eastern session, Washington, D. C.

SEPTEMBER

6-10, American Chemical Society, 114th national meeting, Midwest session, Jefferson Hotel, St. Louis, Mo. (NOTE—this session of the 114th national meeting will include meetings of the Petroleum Chemistry Division.)

13-17, Third Instrument Conference and Exhibit, Convention Hall, Philadelphia.

13-17, American Assn. for the Advancement of Science, centennial meeting, Washington, D. C.

13-17, American Chemical Society, 114th national meeting, Western session, Portland, Ore.

15-17, National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.

15-17, American Institute of Chemical Engineers, regional meeting, French Lick Springs, Ind.

20-22, National Butane-Propane Assn., Chicago.

27-28, Independent Petroleum Assn. of America, Plaza Hotel, San Antonio, Texas.

27-Oct. 1, National Plastics Exposition, Grand Central Palace, New York.

OCTOBER

4-9, American Gas Assn., annual convention, technical section, Ambassador Hotel, Los Angeles.

8, California Natural Gas Assn., 23rd annual fall meeting, Ambassador Hotel, Los Angeles.

11-13, National Lubricating Grease Institute, 16th annual convention, Edgewater Beach Hotel, Chicago.

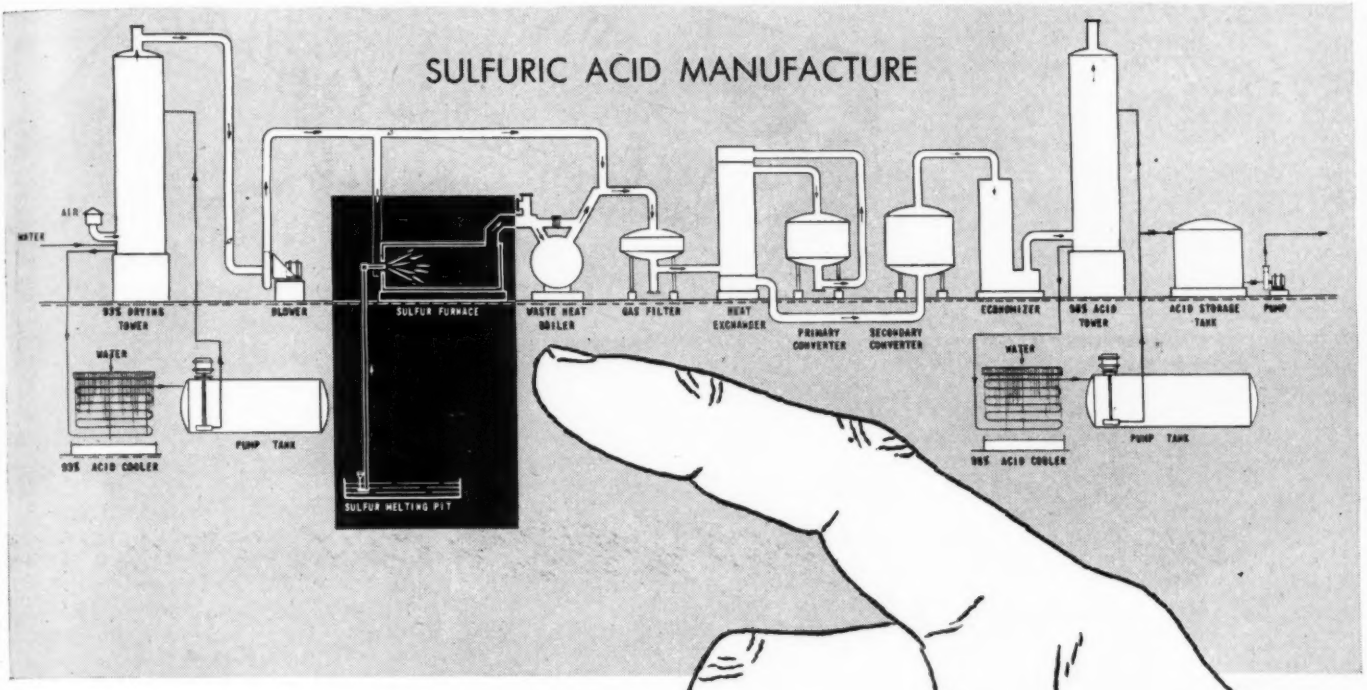
12-16, National Chemical Exposition, Coliseum, Chicago.

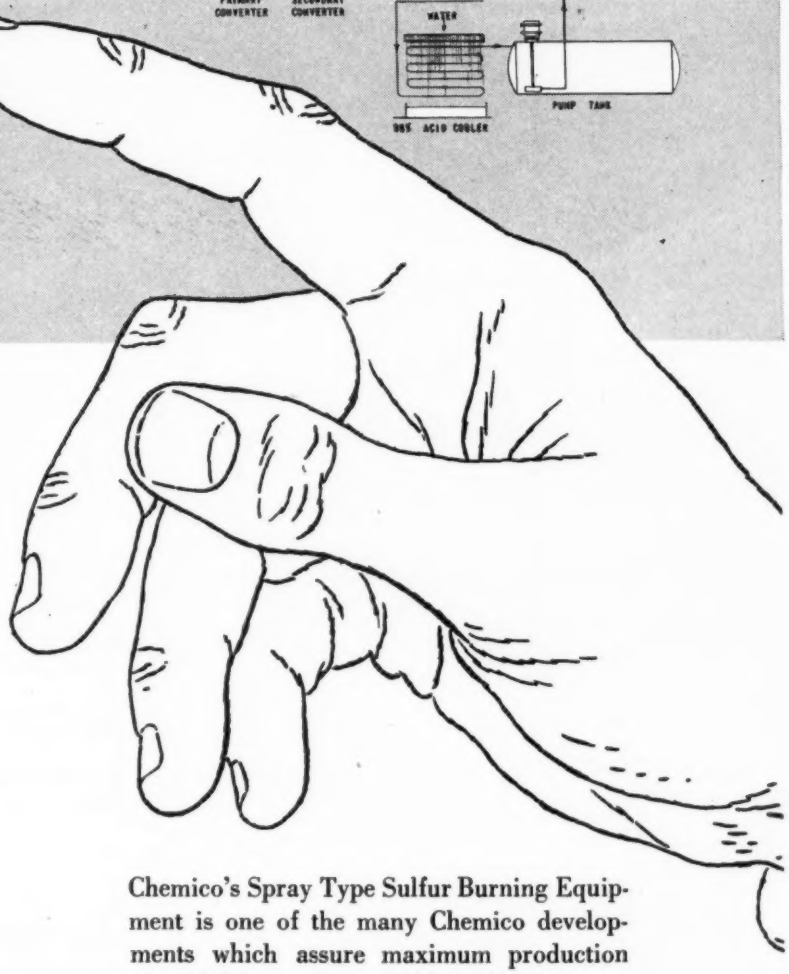
23-29, American Society for Metals, annual convention, Benjamin Franklin Hotel, Philadelphia.

25-29, National Metal Congress and Exposition, Philadelphia.

25-29, American Welding Society, annual convention, Bellevue-Stratford Hotel, Philadelphia.

Maximum production of acid from every pound of sulfur...in a
CHEMICO CONTACT ACID PLANT





Spray Type Sulfur Burning Equipment is an exclusive feature of Chemico contact acid plants . . . a feature which permits:

- ***Complete combustion— no sublimation***
- ***Uniform SO_2 gas strength***
- ***Perfect temperature control for converter operation***
- ***Elimination of moisture and impurities by premelting the sulfur***
- ***Minimum formation of SO_3***
- ***Quick starting and stopping of operation***
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Chemico's Spray Type Sulfur Burning Equipment is one of the many Chemico developments which assure maximum production of acid from every pound of sulfur.

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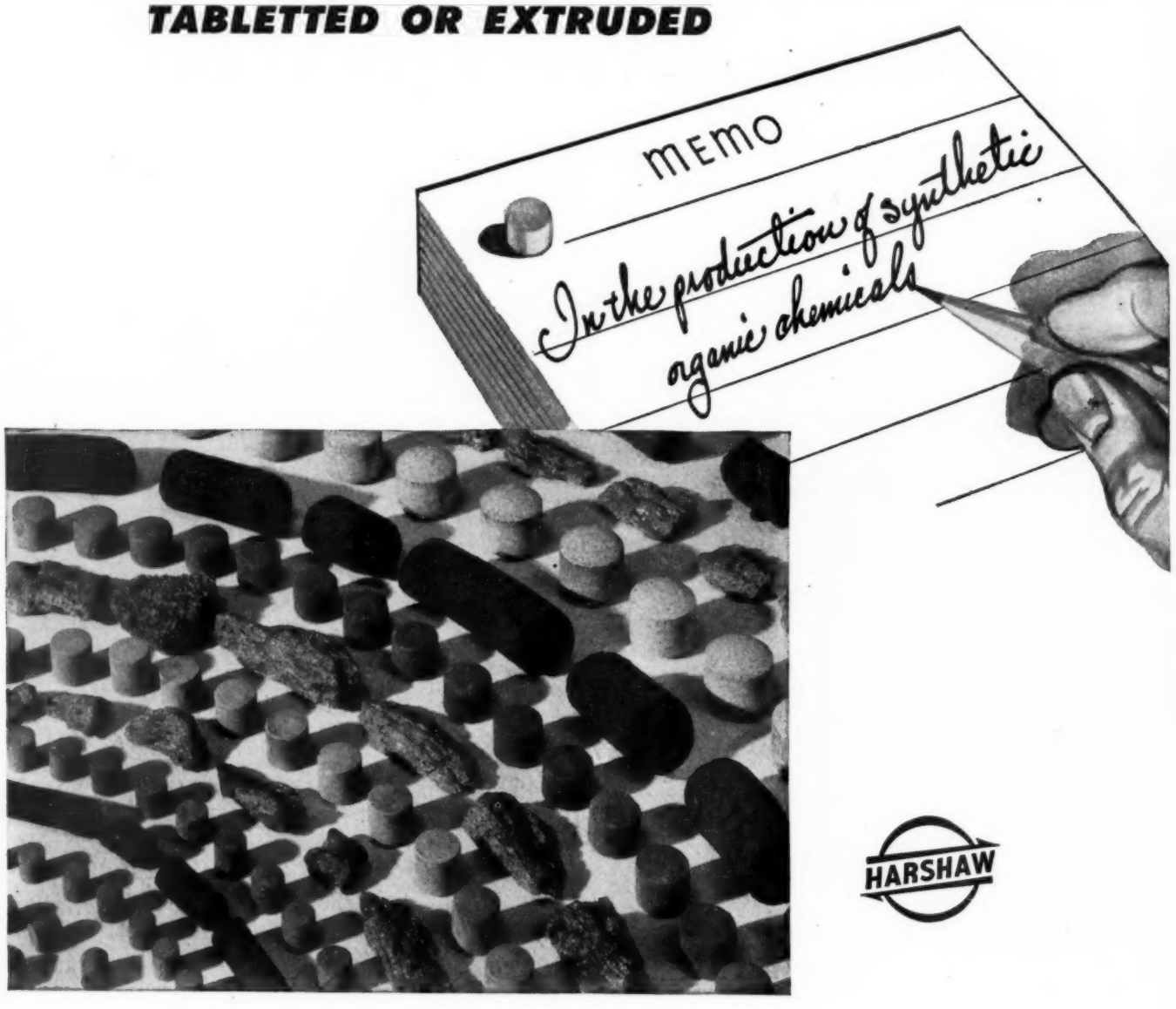

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Great strides have been made in the use of tabletted and extruded catalysts for the production of many synthetic organic chemicals. For a long time Harshaw has studied and developed "fixed bed" catalysts. In addition to supplying preformed catalysts of our development, we also specialize in producing catalysts to specification for your processes. Harshaw now furnishes pelleted catalysts in a variety of sizes for such reactions as hydroforming, cyclization, oxidation, dehydrogenation, hydrogenation, dehydration, and desulphurization. If you have a catalyst problem, a discussion with us may prove helpful.

THE HARSHAW CHEMICAL CO.
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BRANCHES IN PRINCIPAL CITIES

PERSONALS

Petroleum Technologists in the Headlines

C. E. Allen, formerly superintendent of the Light Oil Division of Standard of California's El Segundo refinery, has been appointed president of the California Refining Co., Standard's affiliate at Barber, N. J. He succeeds **Fred Powell,** recently made general manager

Mr. Allen

Mr. Powell

at El Segundo.

Mr. Allen received his degree in electrical engineering from the University of Washington in 1922, worked with a contracting firm where he became vice president and manager and joined Standard of California in 1930. He held various technical positions at the Richmond, Bakersfield and El Segundo refineries and was loaned to the Arabian American Oil Co., Standard affiliate. In 1942 he became assistant superintendent of the El Segundo Light Oil Division and a year later superintendent.

Fred Powell, president of the California Refining Co. from 1946, is general manager of the El Segundo refinery of Standard Oil Co. of California. He succeeds **W. W. Davison,** recently made a vice president of Standard.

Mr. Powell graduated from University of Washington in 1922 in chemical engineering and joined California Standard in 1925, working at the Richmond refinery. He held increasingly responsible positions there until 1938, when he was made assistant to the superintendent of the Bakersfield refinery. In 1941 he was made assistant superintendent at El Segundo and then manager of the refining division there. He was made president of the California Refining Co. in 1946.

* * *

R. M. Prather, Standard Oil Co. of Indiana, last month was elected recording secretary of the Chemical Market Research Association. He has been with Indiana Standard since 1945, in charge of market research activities for that company's chemical products department.

The appointment of **Dr. C. D. Lowry, Jr..,** as Executive Director of the Panel on Petroleum of the Research and Development Board, National Military Establishment, has been announced by Chairman Dr. Vannevar Bush.

Dr. Lowry, a member of the staff of the Universal Oil Products Co., has been with that organization for more than twenty years.

* * *

Recent promotions at Pure Oil Co.'s Heath Refinery, Newark, Ohio, which resulted from expanded operations and broader responsibilities, according to J. Porter Langfitt, company's vice president for refining, were:

E. E. McPherson, with Pure Oil for 28 years, becomes refinery manager. **Dale G. Miller** was advanced from assistant superintendent to general superintendent. Mr. Miller has been with Pure for 17 years. **Harry Hook,** a 25-year employe, was made superintendent of operations, and **Ensel A. Hall** superintendent of maintenance. Mr. Hall has been with the company for 21 years.

* * *

Stanley C. Hope, formerly president of Gilbert & Barker Mfg. Co. and Stanco Inc., affiliate of Standard Oil Co. (New Jersey) has been elected executive vice president and director of Esso Standard Oil Co. Starting with Gilbert & Barker, Mr. Hope held positions as New York and European sales manager, in 1927 became vice president, and in 1932 president of the company. In his new position he succeeds **A. Clarke Bedford,** who, in his 35 years' experience with New Jersey Standard and its affiliates, occupied positions in its production, manufacturing, and marketing operations

Mr. Hope

* * *

W. H. Stewart, Sun Oil Company, Beaumont, Texas, was elected Chairman of the Corrosion Research Project Committee of the Natural Gasoline Association of America at a meeting of the group in Dallas May 26. **F. A. Prange,** Phillips Petroleum Co., Bartlesville, was elected Vice-Chairman of the committee and succeeds **M. E. Holmberg** of the same company. The new Steering Committee, of which Mr. Stewart is also chairman, is composed of the following: **F. A. Prange,** Vice Chairman; **T. S. Bacon, Walter Rogers,** Gulf Oil Corporation, Houston; **P. P. Spafford,** Stanolind Oil & Gas Co., Houston; and **T. S. Zajac,** Shell Oil Co., Inc., Houston.

* * *

Two promotions in Warren Petroleum Corp.'s manufacturing division have been announced by H. W. Harts, vice president. They are **L. M. Mauney,** to general superintendent of plant operations, and **Rex Lane,** to chief engineer in charge of construction and maintenance.

Mr. Mauney

Mr. Lane

Mauney moves into his new position after 15 years with the organization. He joined Amerada Petroleum Co. in 1933 as a Podbielniak analytical operator and later became a plant chemist. While still with Amerada, he was one of the pioneers in marketing a butane mixture to drillers and domestic users and in helping to develop new sources of supply.

Lane joined the engineering staff of Sinclair Prairie Oil & Gas Co. in 1928, and was assistant chief engineer at the time he resigned in July of 1942 to become affiliated with the Chemical Construction Corp., at Dumas, Tex. In 1943 he became a member of Warren's engineering staff where he has directed considerable engineering work, including the construction of the Houston Products Pipe Line in Texas, the corporation's Norsworthy terminal addition, and development of the design for the Holliday, Tex., natural gasoline plant.

* * *

Richard Mungen has been promoted from chemical engineer to be research group supervisor and director of the chemical engineering group of the process section, research department, Stanolind Oil & Gas Co., Tulsa.

Oil tells
a great story...
and you can
write your
own chapter...

HOW 34,000 OIL COMPANIES SERVE THE NATION...
'In hamlet and village, big city and country, jobbers and distributors of all sizes work round-the-clock to keep oil "on the move" to you.

THE BIGGEST JOB THIS JOBBER EVER DID

Keeping Your Community Supplied with Oil

• It's a big job to take crude oil from the earth and turn it into the oil products you use. But the oil industry's efforts to supply you can't end there.

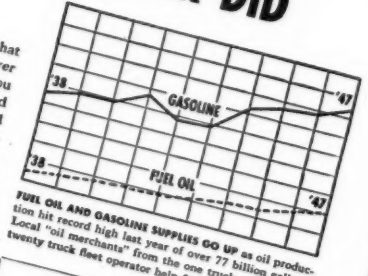
Gasoline, fuel oil, kerosene and other products must be *delivered* to you – when and where you want them. That's why your local oil jobber plays such an important role in the oil industry.

Today, there are over 20,000 independent marketing companies of all sizes working night and day, winter and summer, to see that the oil being produced now—the most oil ever produced—gets through to you wherever you live. Fuels and lubricants for your cars and trucks . . . fuel oil to heat your homes and schools . . . gasoline and oil for your farm machinery – *all* are being supplied in record-breaking quantities.

More petroleum products will be delivered this year. Be sure to use them *efficiently*. Oil is energy for America. Oil means more comfort, better living, greater convenience for you.

Your local service station is one of more than 225,000 in the U.S. This year, they'll supply gasoline and lubricants to over 37 million vehicles.

Today, America has over twice as many oil burners as in 1938. Jobbers delivered greatest amount of fuel oil in history this past winter.



FUEL OIL AND GASOLINE SUPPLIES GO UP as oil production hit record high last year of over 77 billion gallons. Local "oil merchants" from the one truck owner to the twenty truck fleet operator help fill your growing needs.

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INFORMATION COMMITTEE
670 Fifth Avenue, New York 19, N. Y.

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Your customers, in your community, want to know how your branch of the business is meeting their record demands for oil. Help them understand the job you're doing . . . help yourself to the good will so important to the success of your business. It's easy to do. Put this national campaign to work over your own signature—it will win friends for you and your firm.

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Please forward at once FREE copy of Tie-in material.

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Title .....
Company .....
Address .....
City ..... *State* .....

Personals

Universal Oil Products Company has appointed **C. R. Végh Garzón** of Montevideo, Uruguay, as consultant in Latin America.

Mr. Végh Garzón

Mr. Végh Garzón, who founded the South American Petroleum Institute (I. S. A. P.), has served since 1940 as president of the Uruguayan Section and chairman of the International Council.

In 1946 he became technical and commercial advisor to the "Refinaria de Petroleos do Distrito Federal S. A." for the construction of a petroleum refinery in Rio de Janeiro.

Mr. Végh Garzón has been actively serving the Uruguayan Government in technical projects since receiving his engineering degree from the University of Montevideo in 1926.

* * *

V. F. Beyer and **E. W. Carlson,** formerly with Standard Oil Co. of New Jersey, have formed the Bryton Co. and have a plant at Matawan, N. J., for the manufacture of surface active agents.

E. W. Isom, director of research and development, Sinclair Refining Co., has been awarded the Medal of Merit conferred by the Colorado School of Mines for "outstanding achievement." The medal, which has been awarded to only five other members of the school's alumni, was presented to Mr. Isom at commencement exercises May 28.

* * *

John Y. Beach, James O. Clayton and **Ronald T. Macdonald,** three scientists of the Richmond laboratories of California Research Corp., have been designated research associates in recognition of their technical achievements. Dr. Beach is the company's technical specialist and consultant in spectrography, x-ray, and electron diffraction. Dr. Clayton is recognized as an expert in compounded lubricating oils. Dr. Macdonald is in the company's grease and industrial lubricants division.

* * *

John W. Barker, formerly of Houdry Process Corp. and Foster Wheeler Corp. of New York City, has joined the engineering staff of George Armistead, Jr., consulting chemical engineer of Washington, D. C. A graduate of M.I.T. in 1941, Barker has specialized for several years in the design and engineering of refinery process units, as well as the supervision of pilot plant research. He will serve in a general engineering capacity.

CLASSIFIED

Petroleum Processing announces this classified section as a regular feature for the convenience of its readers. Classified rates are shown in the accompanying box.

Classified Rates

"For Sale," "Wanted to Buy," "Help Wanted," "Business Opportunities," "Miscellaneous" classifications, set in type this size without border—20 cents a word. Minimum charge, $5.00 per insertion.

"Position Wanted"—10 cents a word. Minimum charge $2.00 per insertion.

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Copy must reach us not later than 20th of the month preceding date of issue.

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Situations Open

WANTED: Draftsmen with experience, preferably in oil refining. Age 20-40. Good salary. Opportunities for advancement. Write, stating qualifications, to Mr. E. G. Glass, Jr., The Standard Oil Company (Ohio), 1780 Midland Building, Cleveland 15, Ohio.

WANTED: Piping designers with 5-10 years' experience, preferably in oil refining. Age 25-40. Salary over $5,000 per year. Opportunities for advancement. Write, stating qualifications, to Mr. E. G. Glass, Jr., The Standard Oil Company (Ohio), 1780 Midland Building, Cleveland 15, Ohio.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Fuels for the Higher Compression Engines Remain Refiners' Problem

AT THE 1947 SUMMER MEETING of the Society of Automotive Engineers, General Motors' Charles F. Kettering showed the nation's leading automotive and petroleum engineers that a high compression ratio automobile engine could be built and that it would perform as well as conventional engines plus giving up to one-third more miles per gallon than conventional engines. The catch was that 100-octane fuels or better were necessary to operate Kettering's 12.5 to 1 compression ratio powerplant.

But even a year ago, refiners were faced with (1) spiraling demands for more and more petroleum products —burning oils, heating oils, Diesel fuels, etc.—many from the same boiling range as the cracking unit feed stocks, and (2) the fact that increased octane rating meant increased investments for new facilities and a loss in yield at the rate of about 1% for each octane number improvement. Previously, increased octane had been virtually a by-product of increased yield through cracking.

Today, conditions facing refiners are only growing tougher.

It was readily apparent from the discussions at this year's SAE summer meeting that the automotive industry plans to continue to build higher compression engines. Promising test results on two methods for meeting the fuel demands of the higher compression engines were presented at this meeting. However, both methods are fundamentally mechanical gadgets. Announced some time ago, one method is an injection device to supply the needed octanes at costs competitive with refinery methods. The other method, while not yet tested on a cost basis, is a means for saving octanes by using the high grade fuels only as needed, operating the automobile on low grade fuels for most normal cruising speeds.

This does not seem to be the logical overall solution to the problem. Mechanical devices which depend for their successful operation on some degree of care by the driver could be effective in fleet operations. However, the question of their acceptance by individual car owners is an entirely different matter. At the present outlook, the supplying of higher octane fuels for higher compression engines remains a job for refiners. It will call for heavy plant investments and cost some loss in product yield. These factors must be balanced against fuel economies resulting from higher compression engines.

The Cost of Natural Gas vs Petrochemical Manufacture

CONCERN IS EXPRESSED in some quarters as to what effect the rising cost of natural gas will have on the development of the petrochemical industry in the Southwest. The price of gas has advanced greatly since just before the war, when the low cost of this raw material was given as the chief argument for bringing the organic chemical manufacturing plants into Texas.

Not only have natural gas prices gone up, but also those for propane and butane and refinery gases containing C_3 and C_4 hydrocarbons. Nowadays gas producers are unwilling to make gas contracts on a flat price, life-of-lease basis. Usually the agreement provides for re-negotiation at 5-year intervals, with initial prices ranging from 4.5 to 7.5c per Mcf. and in some cases it contains automatic provisions for increases after a stated period to 8c and ultimately 10c. Butanes and propane now sell for 6 to 9c per gallon (equivalent to $1.50 to $3 per Mcf.) where formerly the price was 2 to 4c.

This increased cost for natural gas cannot help but affect the cost of synthesizing from it volume products such as motor fuels, for example. For this synthesis operation, public discussions have assumed a cost of 10c per Mcf. for gas in producing 80-octane gasoline at an overall cost of 13c a gallon. Of this cost for the finished product, the cost of gas would amount to 4.4c. If the price of gas were to double, and other synthesizing costs to remain the same, another 4.4c would be added to the cost of the motor fuel product, bringing it to 17.4c per gallon. Today's f.o.b. Tulsa quotations for standard premium gasoline are 11.5 to 13.5c per gallon.

But, it is unlikely that conditions which might double the price of gas to the synthesis plants would leave unchanged over the same period the price of crude or other costs of the petroleum refiner. Thus the economic disadvantage to the gas synthesis operations might not be greatly different from at present, even on the volume motor fuel operation. However, the cost of the gas is a small factor in the cost of the many petrochemicals made in relatively small volume from natural gas, and even future advances in the price of the raw material would have little effect on the total cost of the product.

Increases in the cost of the raw materials for chemical manufacturing from petroleum sources, whether natural gases or refinery gases, would seem to place the oil companies in a more favorable economic position than today as regards the manufacture of chemicals. The oil company, and to a certain extent the natural gasoline manufacturer, has a choice over its raw material for chemicals that the outside manufacturer is often denied. They can dovetail their operations in this field with their manufacture of volume products as economic conditions warrant. Also, it is possible that the growing domestic fuel market may keep the price of natural gas high, while market conditions may bring the cost of refinery gases and propane to a point where they give a distinct economic advantage to the oil company or other manufacturer using them as raw material for chemicals.

Refinery Superintendent, Ph. D.

Indicative of the high degree of technical training now required to run a refinery is a recent comment of Robert E. Wilson, chairman of the board of Indiana Standard. In his company, he stated, the superintendents of its three largest refineries—in addition to the vice president in charge of manufacturing—all have Ph.D. degrees in chemistry.

Bottom section of an 18-foot vacuum tower being fitted and match-marked for field erection at one of Wyatt's two modern steel plate fabricating plants.

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